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VANCOUVER ISLAND
ROOSEVELT
ELK/ INTENSIVE
FORESTRY
INTERACTIONS

OCTOBER, 1982 -
SEPTEMBER, 1983

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

Province of British Columbia

A cooperative project between the Ministries of Environment and Forests

VANCOUVER ISLAND ROOSEVELT ELK/INTENSIVE FORESTRY INTERACTIONS

Annual Progress Report
October 1, 1982 - September 30, 1983

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Summary

Studies of elk (Cervus elaphus roosevelti) winter habitat use and calving habitat use were conducted in the CDF (coastal douglas fir) and CWH (coastal western hemlock) biogeoclimatic zones on northeastern Vancouver Island. In addition, information on annual population and animal condition trends was collected.

During the winter, elk migrated to low elevations ($\leq$ 300 m) despite the absence of snow. The area of the cumulative winter home range (January and February) was 8 km^2. Spaced stands, 20 to 40-year-old stands where stem density has been recently reduced, did not occur within this home range, although such stands were abundant within the surrounding low elevation areas.

Forage availability (percent cover of species) was studied on 556 plots within the winter home range. Also, overstory density values were recorded for each habitat type.

Highest use per area (radiolocations/hectare) occurred in bogs, mature timber, deciduous-conifer forest, 41 to 60-year-old forest (medium - good site), and 1 to 5-year-old conifer. Lowest use per area occurred in 6 to 10-year-old conifer, 41 to 60-year-old conifer forest (poor site) and 21 to 40-year-old conifer forest.

Habitat selection analysis, using chi-square and a Bonferroni Z-statistic (90%), indicated significant preference for bog habitats throughout the winter; two

habitat types, 6-10 year old conifer and 41-60 year old conifer (poor site), were significantly avoided.

Hemlock (Tsuga heterophylla), grasses, deer fern (Blechnum spicant), twinflower (Linnaea borealis) and sedges (Carex spp.) were the five major food items throughout the winter period, accounting for approximately 80% of the diet, based on fecal fragment analysis.

Preliminary analysis suggests that winter habitat selection was related to food selection. Among habitats that provided high hemlock availability (the major winter food item), elk use was highest in those which also provided high availability of the relatively preferred species, deer fern, grasses, and twinflower.

Calving habitat use was studied by radiolocating four adult cows throughout the calving season (late May - mid-June). Calving sites were located for 3 of 4 cows. These sites were generally located away from valley bottoms on benches within steep terrain. Calving cover requirements remain uncertain due to low sample size.

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1 INTRODUCTION

Elk (Cervus elaphus roosevelti) management on Vancouver Island depends upon the protection or provision of important elk habitats through integrated forest management. Thus, knowledge about elk habitat needs and the impacts of intensive forest management practices on these needs is basic for effective integration of both resources. The present study was initiated in 1981 to provide this knowledge. The project is part of the Integrated Wildlife-Intensive Forestry Research (IWIFR) program, a five year cooperative project between the Ministries of Environment and Forests.

This report outlines research methods and results for the IWIFR elk project during the second year (1982/83). Previous reports include the problem analysis (December 1980), the working plan (December 1980) and three semi-annual progress reports (September 1981, April 1982 and September 1982).

2 OBJECTIVES

The general objective of the project is to collect and provide information on elk habitat use in immature forests and to assess the response of elk habitat use and numbers to the various silvicultural treatments associated with intensive forestry.

Specific objectives for the 1982/83 year were to:

(a) document patterns of habitat use for elk wintering in an area dominated by immature forests;

(b) document food habits, activity budgets and fecal crude protein trends of the elk throughout the winter period;

(c) relate the above trends to habitat use patterns;

(d) study the influence of weather, canopy closure and forage availability on winter habitat selection;

(e) document habitat use of adult cow elk during the calving period;

(f) follow annual population and condition trends of two migratory elk herds.

3 STUDY AREA

The principal study area is the Salmon River watershed, approximately 30 km northwest of Campbell River on Vancouver Island (Figure 1). This watershed is under two major forest tenures - the Sayward Provincial Forest (SPF) and Tree Farm License (TFL) #7, held by MacMillan Bloedel Ltd. (Menzies Bay Division).

The winter work was conducted on the migratory Greenstone elk herd that winters north of Campbell Lake in the SPF. The winter range, as delineated by radiotelemetry locations, is shown in Figure 1 as (A). Immature conifer forests (21 to 60-year-old) cover 70% of this area (Figure 2). The remainder of this area is made up of 1 to 20-year-old conifer stands (12%), bogs (7%), deciduous stands (8%) and old growth (3%). Elevations range from 150 to 300 m. A description of habitats within the winter range is presented in the Results section.

The calving work was done on the migratory Grilse herd that summers at Grilse Creek within TFL #7 [shown in Figure 1 as (B)]. This area is comprised of approximately equal proportions of mature conifer and early regenerating (1 to 10-year-old) conifer forests. Elevations range from 425-700 m.

4 METHODS

4.1 Winter 1983

4.1.1 Habitat Use and Assessment

Habitat use was described through five monitoring sessions in January and February, for one radio-collared cow

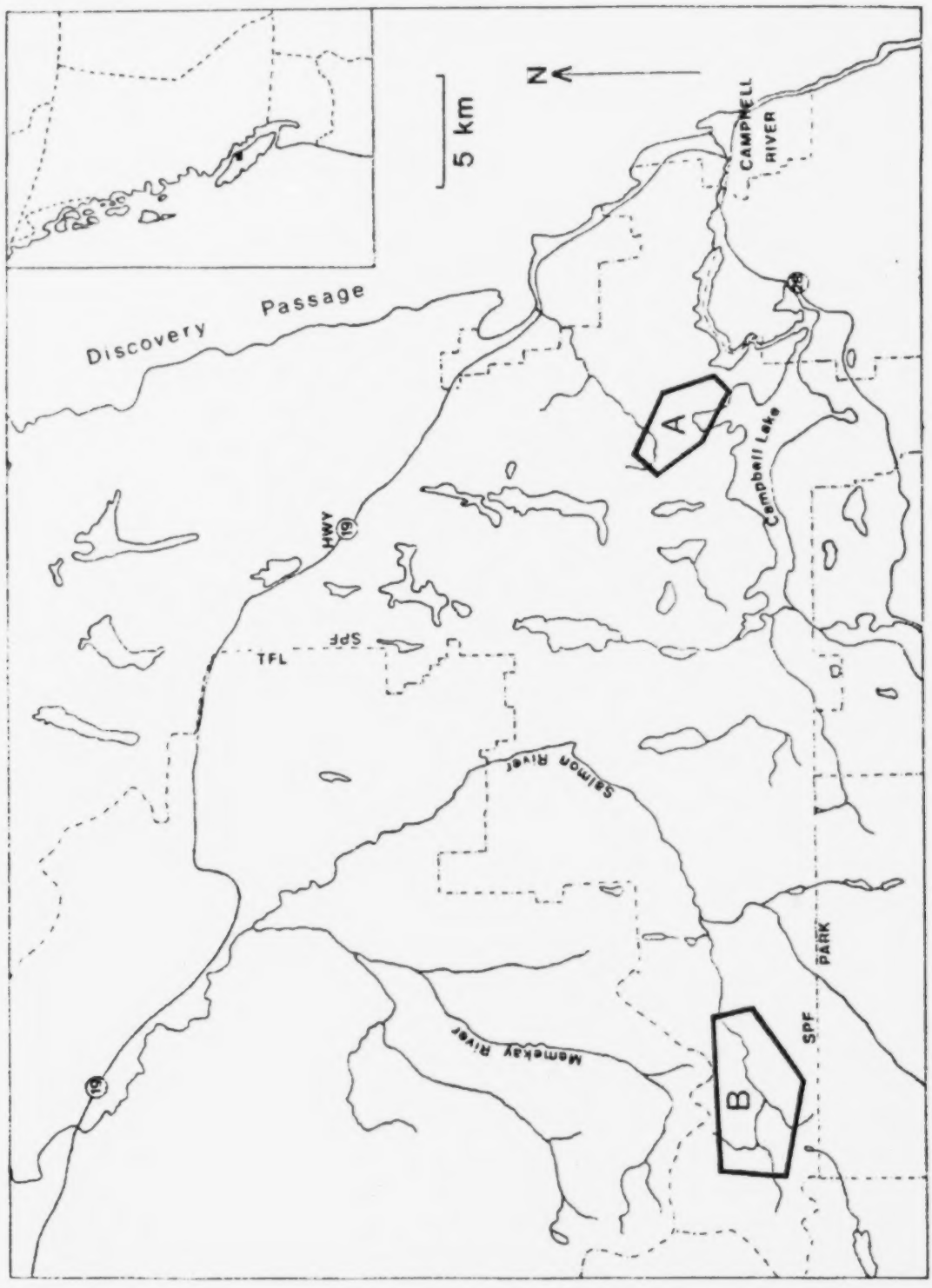


Figure 1. The Greenstone elk herd winter study area (A) and the Grilse elk herd calving study area (B) in the Salmon River watershed, Vancouver Island, B.C.

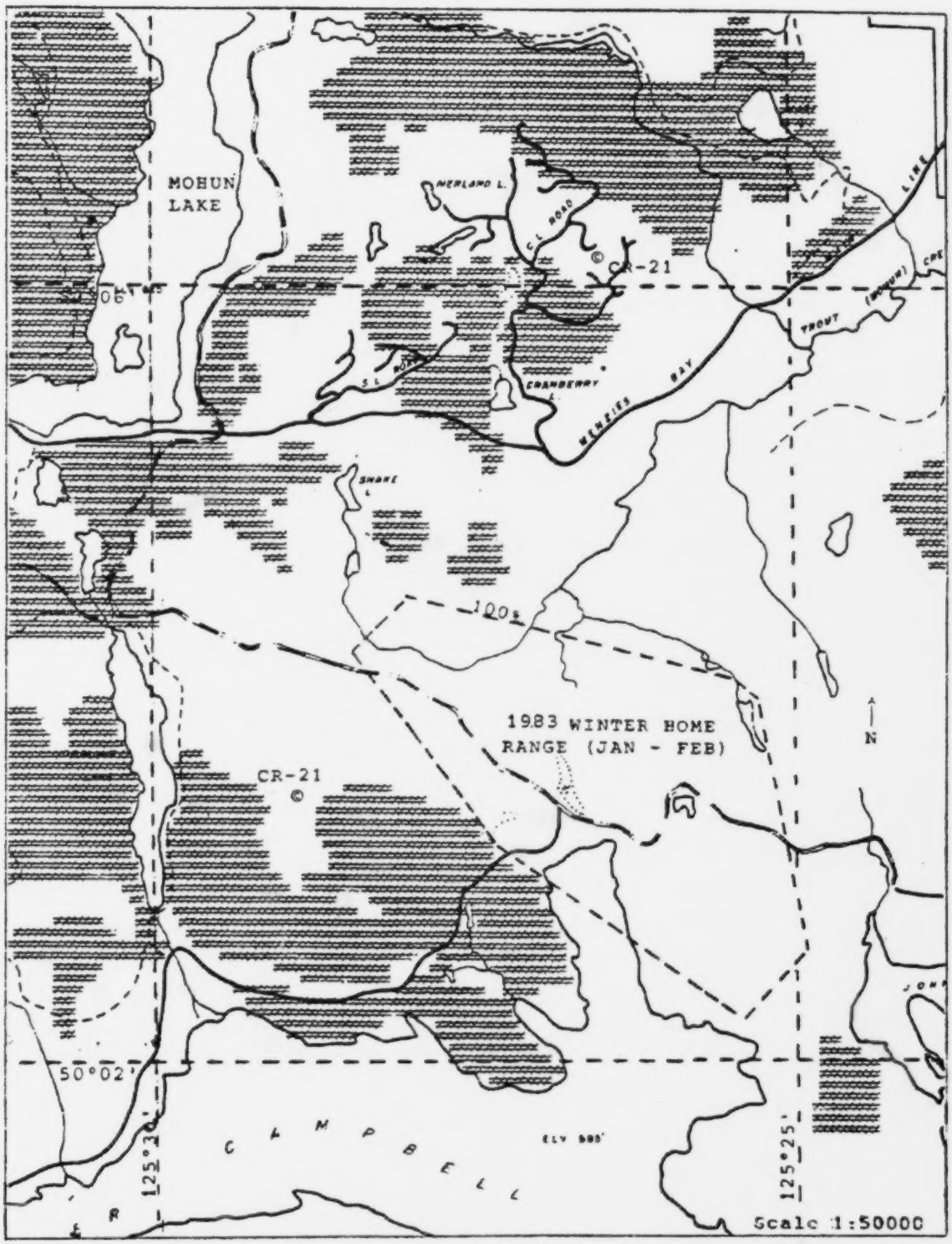


Figure 2. The Greenstone elk herd 1983 cumulative winter home range, as determined from radiolocations, and its relation to CR 21 weather stations and spaced stands (hatched) in the SPF.

elk; this particular animal was associated with a group of elk which varied in group size (10-30). Monitoring sessions generally lasted 4 days each. Each day consisted of two 8-hour periods in which locations were obtained hourly. These 8-hour periods were spaced systematically so that within each monitoring session sampling effort was spread equally throughout the 24 hour cycle. Radio locations from all sessions were pooled. Each radio location was plotted on a 1:10 000 colour air photo and assigned to a habitat type. Chi-square and Bonferroni Z were used to analyse use-availability (Neu et al. 1974).

Elk activity was recorded with a Rustrak recorder over three of the monitoring sessions, 24 hours a day; during the first two sessions activity was not monitored due to receiver failure. Activity strip charts were divided into one-tenth hour intervals and analyzed manually for inactive, active head up and active head up - head down signals; both amplitude and period (time between pulses) information were used to distinguish these activity types. Pilot observation-recording studies have shown that the head up - head down active recordings are indicative of grazing or feeding bouts; head up active recordings are indicative of any range of activities including browsing, standing and travelling; and inactive recordings are indicative of bedding and ruminating activities.

Fresh pellet samples ($n \geq 8$ groups) were collected from the monitored elk on three dates during the winter (January 16, February 13, February 22). Samples were pooled to prepare a composite, winter, diet sample. Diet composition was estimated by fecal fragment analysis.

Habitat assessment was examined on a home range basis. Each 4-day home range was estimated using the minimum area method (Mohr 1947). Within each 4-day home range, habitat

types were delineated from 1:10 000 colour air photos and 1:20 000 forest cover type maps (Figure 3). After each monitoring session, forage availability plots were placed in each habitat type occurring in the 4-day home range. Forage availability was assessed by visually estimating percent ground cover of all species below 2 m in a 5 X 5 m quadrat. At each plot center, overstory density was estimated using a spherical densiometer (four readings were taken in cardinal directions and averaged to obtain the plot overstory density value).

Forage availability data were analyzed by forage class (conifer, shrub, forb, fern, grass, sedge) and by species. Habitat data were grouped from all monitoring sessions. Normality tests indicated a skewed distribution of species and forage class coverage values within habitat types, and therefore contingency table analysis was used to test for significant differences between types (W. Bergerud, pers. comm.). T-tests were used to test for differences in overstory density between types.

4.1.2 Weather Monitoring

Weather was monitored by two CR-21 weather stations situated in open sites within the winter study area (Figure 2). These stations were programmed to record hourly temperature, wind speed, and daily mean wind direction. In addition, a snow station network to monitor snow depths was established at open sites throughout the study area.

4.2 Calving 1983

Calving sites were determined by monitoring four radio collared cows from the Grilse herd. These cows were located approximately four times daily from May 30 through June 15.

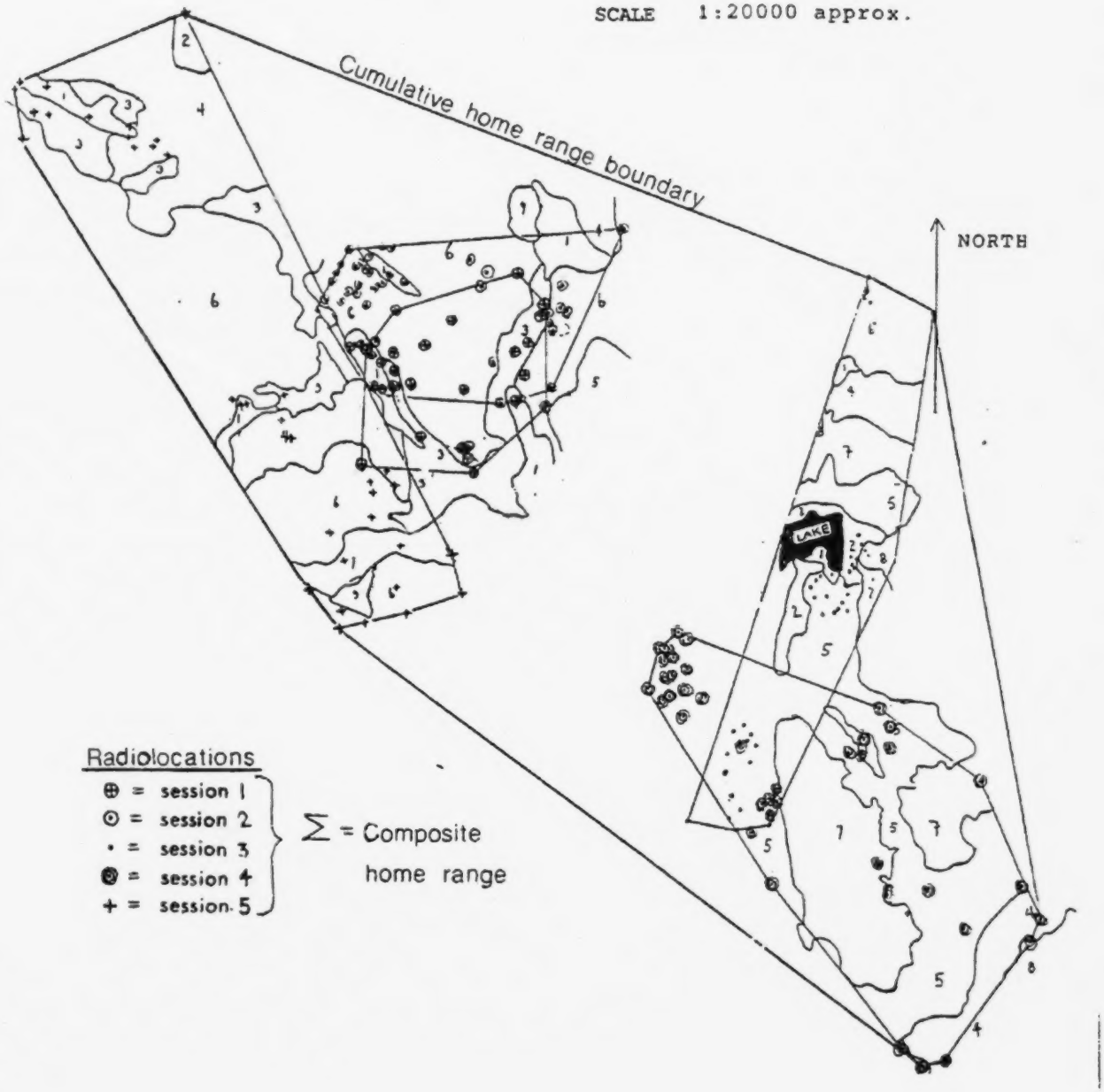


Figure 3. The composite and cumulative home range, January through February 1983, showing elk radiolocations and the spatial distribution of habitat types

Locations were spread throughout the 24-hour period. Cows were monitored up to two weeks post-calving or until they rejoined cow groups within the area.

Radiolocations were plotted on 1:10 000 colour air photos to delineate calving sites. Chi-square analysis using a Bonferroni Z statistic was used to examine post-calving habitat selection.

For each calving site, the following characteristics were measured or noted: elevation, habitat type, slope, terrain, aspect, understory species, overstory height, overstory age, distance to open water, distance to mature timber, distance to other vegetative cover, crown closure, and hiding cover. Hiding cover was measured using a 1.8 X 0.6 m vertically placed sighting tube (Leckenby et al. 1976). The proportion of tube obscured was recorded as a percentage at 20 m intervals from the tube along the following six compass bearings: 0°, 60°, 120°, 180°, 240°, 300°. Measurements were taken in each direction until the tube completely disappeared from view.

As well as the above site features, the weather on the calving study area was monitored using two CR-21 weather stations, one in the open and the other in mature timber. These stations recorded hourly temperature, maximum wind speed, and daily mean wind direction, from late May until September.

4.3 Other Methods

Twenty-one radio collared elk within the larger SPF and TFL 7 study area were located monthly throughout the year to determine annual home ranges and monitor mortality.

To determine seasonal food habits and animal condition, fresh pellet groups ($n \geq 8$ groups) were collected monthly for the two major herds within the study area (Grilse and Greenstone).

Kidneys, obtained from samples of the 1981 and 1982 hunting seasons, were examined to compare percent of fat to total kidney weight. A higher kidney fat index (KFI indicates higher plane of nutrition (Hanks 1981).

Helicopter surveys were conducted in April - May 1983 to estimate the decline in the calf:100 cow ratio from August 1982, and in August 1983 to estimate productivity in 1983. Sample sizes were derived using the formula,

$$n = \frac{No}{1 + (No/N)}, \text{ where } No = t^2 \frac{pq}{d^2}$$

N is the estimated herd size, t is the t value for the appropriate confidence interval, p is the calf: 100 cow ratio, q is 1 - p, and d is the maximum desired error in the calf: 100 cow ratio (Cochran 1977). Sample sizes for estimating calf: 100 cow ratios with 3% error and 80% confidence are shown in Table 21.

5 RESULTS

5.1 Winter 1983

5.1.1 Winter Range

Home ranges were obtained for one 2-day period and four 4-day periods during January and February. Excluding the first short period, the mean 4-day home range size was 1.1 km^2. Home range sizes increased progressively through the winter (Table 1). The composite area of all five home ranges was 4.2 km^2, while the area of the entire (cumulative) winter range was 7.9 km^2.

Table 1. Sessional, composite[a], and cumulative[b] home range sizes during January and February 1983 for the Greenstone elk herd

Monitoring session	Duration (days)	Dates	Number of locations	Home range size (km^2)
1	2	Jan 5 - 7	26	0.5
2	4	Jan 14 - 18	46	0.6
3	4	Jan 25 - 28	41	0.8
4	4	Feb 10 - 13	45	1.3
5	4	Feb 19 - 22	36	1.7
composite	18	all of the above	194	4.2
cumulative	49	Jan 5 - Feb 22	194	7.9

a The composite home range includes all areas enclosed within all sessional home ranges.

b The cumulative home range is that area enclosed by connecting the outermost radio location points from all sessions (see Figure 2 for illustration).

Ten habitat types were delineated for the cumulative winter range (Table 2). Of these types, nine occurred within the boundaries of the five home ranges or composite winter range (Figure 3). No significant difference ($P > .10$) was found between the distribution of habitat types in the cumulative and composite winter ranges.

A description of each habitat type within the composite winter range is presented in Table 3. Immature conifer forests (21 to 60-year-old) represented 70 percent of the composite range. Spaced stands did not occur within either the composite or cumulative winter range (Figure 2).

5.1.2 Habitat Use

Habitat use, based on 194 locations of a radio collared cow elk, was distributed unequally between types (Table 4). Types 5 and 6 received the highest use, although this use occurred in almost equal proportion to their areal occurrence (Figure 4). Type 1 (bog) was used almost twice as often as expected based on areal occurrence, and was the only significantly preferred habitat ($P < .10$) (Table 5). Types 4 (41 to 60-year-old conifer - poor site) and 7 (6 to 10-year-old conifer) were used significantly less than expected ($P > .10$).

5.1.3 Forage Availability

Forage availability, based on 556 plots distributed through nine habitat types (Table 6), varied significantly ($P < .10$) between certain types. Contingency table comparisons of percent cover by forage class (Table 7) indicate that in the conifer class, types 2, 3, 4, 6, and 7

Table 2. Habitat types delineated for the composite and cumulative home ranges of the Greenstone elk herd, January and February 1983

Habitat type		Composite home range area		Cumulative home range area[a]	
No.	Descriptor	hectares	%	hectares	%
1	bog	28	6.6	39	4.9
2	residual old growth	9	2.1	13	1.7
3	deciduous - conifer complex	34	8.1	50	6.3
4	41-60 conifer - poor	60	14.2	95	12.1
5	41-60 yr conifer - med-good	95	22.3	209	26.6
6	21-40 yr conifer - med	142	33.5	274	34.8
7	6-10 yr conifer	52	12.2	97	12.3
8	1-5 yr conifer	2	0.5	2	0.3
9	residual cedar	2	0.5	4	0.5
10	rock bluff	--	--	4	0.5
Total		424	100.0	787	100.0

[a] A lake which occurred within this home range area was excluded for these calculations.

Table 3. Description of the nine habitat types in the 1983 composite winter range

Type	Description
1	Bogs: mostly dominated by Myrica gale and Carex spp. with standing water over most of the area averaging 0.3-0.6 m deep; includes drier scrub timber patches associated with the bog; understory is dominated by Gaultheria shallon, Vaccinium oxycoccus and Blechnum spicant. Mean overstory density of 2%.
2	Old Growth: residual patches over 200 years of age; Pseudotsuga menziesii, relatively open canopy with understory dominated by G. shallon and mosses; frequent small rocky openings and bluffs. Avg. ht. approx. 28-46 m. Mean overstory density of 59%.
3	Deciduous-conifer complex: wetter sites having small stands of Alnus rubra dominating overstory as well as mixed A. rubra, Tsuga heterophylla and P. menziesii stands; average age approximately 40 yrs; understory frequently composed of G. shallon, Rubus spectabilis, Oplopanax horridus, B. spicant, Vaccinium parvifolium and Polystichum munitum; occurrences of Lysichitum americanum. 10-19 m avg. ht. Mean overstory density data not collected.
4	41 to 60-year-old conifer-poor: regenerating conifer with a P. menziesii dominated overstory; between 41 and 60 years of age and 10-19 m in height; rated as a poor site index with many small rocky openings; understory dominated by G. shallon, Mahonia nervosa, and Thuja plicata. Mean overstory density of 64%.
5	41 to 60-year-old conifer med-good: regenerating conifer with a P. menziesii dominated overstory; between 41 and 60 years of age and 10-19 in height; site index ratings medium to good with numerous small rocky openings and small bogs; understory dominated by G. shallon with frequent occurrence of V. parvifolium. Mean overstory density of 58%.

Table 3. con't

Type	Description
6.	21 to 40-year-old conifer: regenerating conifer with a P. menziesii dominated overstory; between 21 and 40 years of age and 10-19 m in height; frequent rocky openings with G. shallon and V. parvifolium dominating the understory. Mean overstory density of 54%
7.	6 to 10-year-old conifer: regenerating P. menziesii stands 6 to 10 years of age with patches of Pinus sp. on drier sites; understory dominated by G. shallon, with Linnaea borealis occurring frequently; frequent dry rocky outcrop areas. 0-10 m in height. Mean overstory density of 9%.
8.	0 to 5-year-old conifer regen: regenerating P. menziesii stands 5 yrs. of age or less; heavy browsing by deer evident in portions; understory dominated by G. shallon, M. nervosa, and V. parvifolium. No overstory.
9.	Residual Cedar stands: mature conifer stand dominated by T. plicata approx. 200 years of age; adjacent to bogs; 28-38 m in height; dead and down Thuja plicata in some areas; wet sites with understory dominated by G. shallon, with V. parvifolium and some Cornus canadensis. Mean overstory density of 76%.

Table 4. Percent radiolocations and areas by habitat type and monitoring session for the Greenstone elk herd, January - February 1983

		Monitoring session											
		1		2		3		4		5		Totals	
No.	Habitat type	Area (%)	Locations (%)	Area (%)	Locations (%)	Area (%)	Locations (%)	Area (%)	Locations (%)	Area (%)	Locations (%)	Area (%)	Locations (%)
1	bog	7.7	15.4	12.7	23.9	1.7	2.4	1.4	4.4	9.1	19.4	6.6	12.8
2	residual old growth	--	--	--	--	8.1	17.1	0.3	4.4	1.3	2.8	2.1	5.1
3	deciduous-conifer complex	22.6	38.5	11.7	15.2	--	--	--	--	13.9	13.9	8.1	11.3
4	41-60 yr conifer (poor)	7.7	--	1.5	--	8.7	--	7.0	6.7	25.6	25.0	14.2	6.2
5	41-60 yr conifer (med-good)	--	--	--	--	49.7	58.5	57.8	77.8	--	--	22.3	30.4
6	21-40 yr conifer	62.0	46.1	73.5	60.9	13.3	12.2	--	--	49.0	38.9	33.5	30.4
7	6-10 yr conifer	--	--	--	--	15.9	2.4	33.1	6.7	--	--	12.2	2.1
8	1-5 yr conifer	--	--	--	--	2.6	7.3	0.2	--	--	--	0.5	1.5
9	residual cedar	--	--	0.7	--	--	--	--	--	1.1	--	0.5	--
Totals (hectares, locations)		45 h	26	59 h	46	77 h	41	128 h	45	166 h	36	424 h	194

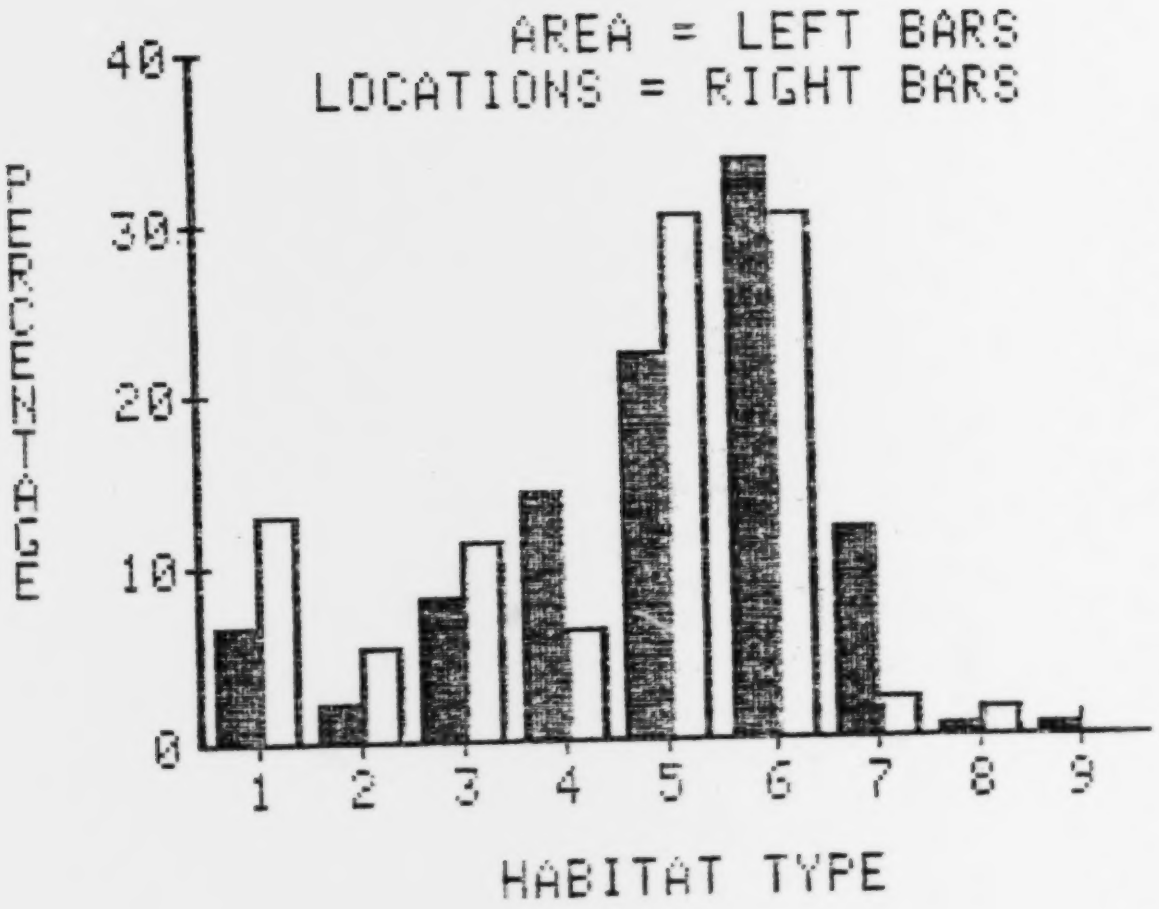


Figure 4. Comparison of percent areas of habitat types on the composite winter range with their use by elk in January - February 1983

Table 5. Proportion and occurrence of radio-locations on the composite winter range, during January-February 1983

Habitat type	Total hectares	Number of locations	Proportion of total hectares (p_{i0})	Proportion of locations (p_i)	90% confidence intervals[a]	Selection[b]
1	28.0	25	0.066	0.129	$0.068 \leq p_i \leq 0.190$	+
2	8.9	10	0.021	0.052	$0.011 \leq p_i \leq 0.092$	0
3	34.2	22	0.081	0.113	$0.055 \leq p_i \leq 0.171$	0
4	60.3	12	0.142	0.062	$0.018 \leq p_i \leq 0.106$	-
5	94.5	59	0.223	0.304	$0.220 \leq p_i \leq 0.388$	0
6	142.0	59	0.335	0.304	$0.220 \leq p_i \leq 0.388$	0
7	51.5	4	0.122	0.021	$0 \leq p_i \leq 0.047$	-
8	2.2	3	0.005	0.015	$0 \leq p_i \leq 0.037$	0
9	2.1	-	0.005	0	-	0
Totals	423.7	194	1.000	1.000		

[a] The confidence interval is calculated as $p_i - Z(1 - \alpha/2k)\sqrt{p_i(1-p_i)/n} \leq p_i \leq p_i + Z(1 - \alpha/2k)\sqrt{p_i(1-p_i)/n}$ (Neu et al. 1974)

[b] Where p_{i_0} is less than the confidence interval on use, then positive selection is inferred.

Where p_{i_0} is greater than the confidence interval on use, then negative selection in inferred.

Table 6. Distribution of forage availability plots by habitat type and monitoring session, January to February 1983

Habitat		No. of plots per monitoring session				
Number	Descriptor	1 and 2[a]	3	4	5	Total (%)
1	bog	35	13	--	15	63(11)
2	residual old growth	--	19	9	10	38(7)
3	deciduous-conifer complex	30	--	--	13	43(8)
4	41-60 yr conifer - poor site	25	4	26	22	77(14)
5	41-60 yr conifer - med-good	--	37	20	--	57(10)
6	21-40 yr conifer - med site	93	16	--	59	168(30)
7	6-10 yr conifer	--	34	20	--	54(10)
8	1-5 yr conifer	--	10	30	--	40(7)
9	residual cedar	16	--	--	--	16(3)
10	rock bluff[b]	--	--	--	--	--(0)
Distribution by session (%)		199 (36)	133 (24)	105 (19)	119 (21)	556(100)

a Sessions 1 and 2 were combined because their home range areas overlapped.

b Habitat type 10 did not occur in any sessional home ranges.

Table 7. Results of contingency table analysis for forage class coverage comparisons between habitat types

Habitat type	Conifers			Shrubs			Forbs			Ferns			Grasses			Sedges		
	>	<	nsd[1]	>	<	nsd	>	<	nsd	>	<	nsd	>	<	nsd	>	<	nsd
1	--	2,3,4 5,6,7 8,9	--	3,8,9	2	4,5,6 7	3	7,8,9	2,4,5 6	--	4,5,6	2,3,7 8,9	2,4,5 6	--	3,7,8 9	2,3,4 5,6,7 8,9	--	--
2	1,7	3	4,5,6 8,9	1,3,5 8	--	4,6,7 9	--	4,6,7 8,9	1,3,5	--	3,5,8 9	1,4,6 7	--	1,3,7 8	4,5,6 9	--	1	3,4,5 6,7,8 9
3	1,2,5 8,9	4	6,7	--	1,2,5 6,7	4,8,9	--	1,4,6 7,8,9	2,5	1,2,4 6,7,8	--	5,9	4,2,5 6	7	8,9	--	1	2,4,5 6,7,8 9
4	1,3,5 8,9	--	2,6,7	9	5	1,2,3 6,7,8	3	7,8,9	1,2,5 6	8,9	3,5	1,2,6 7	--	1,3,5 6,7,8	2,9	--	1	2,3,5 6,7,8 9
5	1	3,4	2,6,7 8,9	3,4,8 9	--	1,2,6 7	--	7,8,9	1,2,3 4,6	1,2,4 6,7,8	--	3,9	4,6	1,3,7 8	2,9	--	1	2,3,4 6,7,8 9
6	1,8	--	2,3,4 5,7,9	3,8,9	--	1,2,4 5,7	3,9	7,8	1,2,4 5	1,8	3,5	2,4,7 9	4	1,3,5 7,8	2,9	--	1	2,3,4 5,7,8 9
7	1,8,9	2	3,4,5 6	3,8,9	--	1,2,4 5,6	1,2,3 4,5,6 8	--	9	--	3,5,8 9	1,2,4 6	2,3,4 5,6	--	1,8,9	--	1	2,3,4 5,6,8 9
8	1	3,4,6	2,5	--	1,2,5 6,8	3,4,9	1,2,3 4,5,6	7	9	2,7	3,4,5 6,9	1	2,4,5 6	--	1,3,7 9	--	1	2,3,4 5,6,7 9
9	1	3,4,7	2,5,6 8	--	1,4,5 6,7	2,3,8	1,3,4 5	--	2,6,7 8	1,2,7 8	4	3,5,6	--	1,2,3 4,5,6 7,8	--	--	1	2,3,4 5,6,7 8

1 > - habitat type n is significantly greater than ($p < .10$)
< - habitat type n is significantly less than ($p < .10$)
nsd - no significant difference ($p > .10$)

had the highest coverages; in the shrub class, types 1, 2, 5, 6, and 7 had the highest coverages; in the forb class, types 7, 8, and 9 had the highest coverages; in the fern class, types 3, 5, and 9 had the highest coverages; in the grass class, types 1, 3, 7, and 8 had the highest coverages; and in the sedge class, type 1 had the only occurrences. Mean percent cover values by forage class (Table 8) generally correspond with contingency table results. Appendix 8.1 presents information on forage class coverage variation throughout each type.

Contingency table comparisons of percent cover by preferred species indicate significant differences in the distribution of these species between the nine habitat types (Table 9). Types 6 and 7 had the highest coverage of Linnaea borealis. Types 3 and 9 had the highest coverages of Blechnum spicant. Types 3, 5 and 6 had the highest coverages of Polystichum munitum. Also, as presented under forage classes above, types 1, 3, 7, and 8 had the highest coverages of grasses. Mean percent cover values by species (Table 10) generally correspond with the contingency table results for species.

A comparison of mean number of species per plot (diversity) with mean percent coverage (abundance) by forage class shows that type 7 (6 to 10-year-old conifer) had the highest forb and shrub abundance and diversity, while type 3 had the highest fern abundance and diversity (Figure 5). This comparison also indicated the similarities in abundance and diversity of all forage classes in types 4, 5 and 6.

No significant correlations ($p > .10$) were found between elk use, based on radio locations, and forage class abundance (Table 11). Correlations between major forage species and

Table 8. Estimated coverage of forage classes in habitat types in the composite home range of the Greenstone elk herd, January - February 1983

Habitat type	Conifer $\bar{X}$(%)	SE	Shrub $\bar{X}$(%)	SE	Forb $\bar{X}$(%)	SE	Fern $\bar{X}$(%)	SE	Grass $\bar{X}$(%)	SE	Carex $\bar{X}$(%)	SE
1	2.7	1.1	75.4	4.1	1.9	0.6	0.4	0.2	13.6	2.8	47.5	4.9
2	12.4	2.5	80.0	5.1	2.3	0.6	0.4	0.2	0.3	0.2	--	--
3	17.0	2.2	47.0	6.2	1.6	0.9	9.1	2.6	4.0	2.0	--	--
4	20.8	2.7	56.3	4.2	2.7	0.6	1.7	0.6	0.04	0.02	--	--
5	9.5	1.7	74.1	4.7	1.7	0.5	6.6	1.5	1.8	1.5	--	--
6	14.5	1.2	67.3	2.8	4.2	0.6	2.5	0.5	1.3	0.2	--	--
7	12.3	2.3	80.8	5.0	17.5	2.5	0.4	0.2	4.9	1.5	--	--
8	4.5	1.1	43.7	5.7	4.7	0.9	0.5	0.3	2.1	0.9	--	--
9	7.2	2.9	29.6	9.3	3.7	1.1	1.5	0.5	--	--	--	--

Table 9. Results of contingency table analysis for preferred forage species coverage comparisons between habitat types (Polystichum munitum was not preferred but was found to correlate with use)

Habitat type	SPECIES: Linnaea borealis			Blechnum spicant			Polystichum munitum			Grasses		
	Contingency Table Analysis Results											
	>	<	nsd[1]	>	<	nsd	>	<	nsd	>	<	nsd
1	--	2,4,5 6,7,8	3,9	7	5,6,9	2,3,4 8	--	2,3,4 5,6,7	8,9	2,4,5 6	--	3,7,8 9
2	3,9	6,7	1,4,5 8	--	--	1,3,4 5,6,7 8,9	1	5,8	3,4,6 7,9	--	1,3,7 8	4,5,6 9
3	--	2,4,5 6,7,8	1,9	4,5,6 7	--	1,2,8 9	1,4,6 7,8	--	2,5,9	2,4,5 6	7	1,8,9
4	1,3,9	6,7	2,5,8	--	3,9	1,2,5 6,7,8	1,8	3,5,6	2,7,9	--	1,3,5 6,7,8	2,9
5	1,3	7	2,4,6 8,9	1	3,9	2,4,6 7,8	1,2,4 6,7,8 9	--	3	4,6	1,3,7 8	2,9
6	1,2,3 4	7	5,8,9	1	3,9	2,4,5 7,8	1,4,8	3,5	2,7,9	4	1,3,5 7,8	2,9
7	1,2,3 4,5,6 8,9	--	--	--	1,3,9	2,4,5 6,8	1	3,5,8	2,4,6 9	2,3,4 5,6	--	1,8,9
8	1,3	7	2,4,5 6,9	--	--	1,2,3 4,5,6 7,9	2,7	3,4,5 8	1,9	2,4,5 6	--	1,3,7 9
9	--	2,4,7	1,3,5 6,8	1,4,5 6,7	--	2,3	--	5	1,2,3 4,6,7 8	--	1,2,3 4,5,6 7,8	--

[1] > - habitat type n is significantly greater than ($p < .10$)
< - habitat type n is significantly less than ($p < .10$)

Table 10. Estimated coverage of diet species in habitat types in the composite home range of the Greenstone elk herd, January - February 1983 (percent occurrence of each species in the diet is indicated in brackets)

	Conifers				Shrubs				Forbs		Ferns				Graminoids			
	Tsuga heterophylla (23.9)		*Thuja plicata* (1.2)		*Gaultheria shallon* (3.4)		*Vaccinium* spp. (3.1)		*Linnaea borealis* (14.1)		*Blechnum spicant* (8.7)		*Polystichum munitum* (2.5)		Grasses (20.2)		Sedges (11.9)	
Habitat type	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE	X̄(%)	SE
1	0.9	0.9	0.5	0.2	10.8	3.1	1.4	0.9	0.1	0.1	0.2	0.1	0.2	0.1	13.6	2.8	47.5	4.
2	3.7	1.7	2.9	1.3	65.7	4.5	3.9	1.3	1.5	0.4	--	--	0.4	0.2	0.3	0.2	--	-
3	7.2	1.9	3.1	0.7	23.2	4.3	4.5	1.1	0.4	0.3	3.2	1.6	5.9	2.1	4.0	2.0	--	-
4	12.5	2.1	6.9	1.6	35.6	3.3	14.6	1.8	0.6	0.1	0.9	0.5	0.8	0.3	0.04	0.02	--	-
5	5.1	1.4	1.5	0.5	51.4	3.6	12.1	1.9	1.1	0.5	0.9	0.7	5.7	1.4	1.8	1.5	--	-
6	6.8	1.0	--	--	39.8	2.3	14.5	1.1	2.7	0.5	0.2	0.1	2.3	0.5	1.3	0.2	--	-
7	0.2	0.1	0.3	0.2	60.8	4.1	6.5	1.9	11.9	2.1	0.1	0.1	0.3	0.1	4.9	1.5	--	-
8	0.7	0.4	0.3	0.2	33.3	4.2	4.7	1.2	2.2	0.7	--	--	0.5	0.3	2.1	0.9	--	-
9	6.6	3.0	0.6	0.1	22.6	6.7	6.8	3.0	0.1	0.1	1.4	0.5	0.1	0.1	--	--	--	-

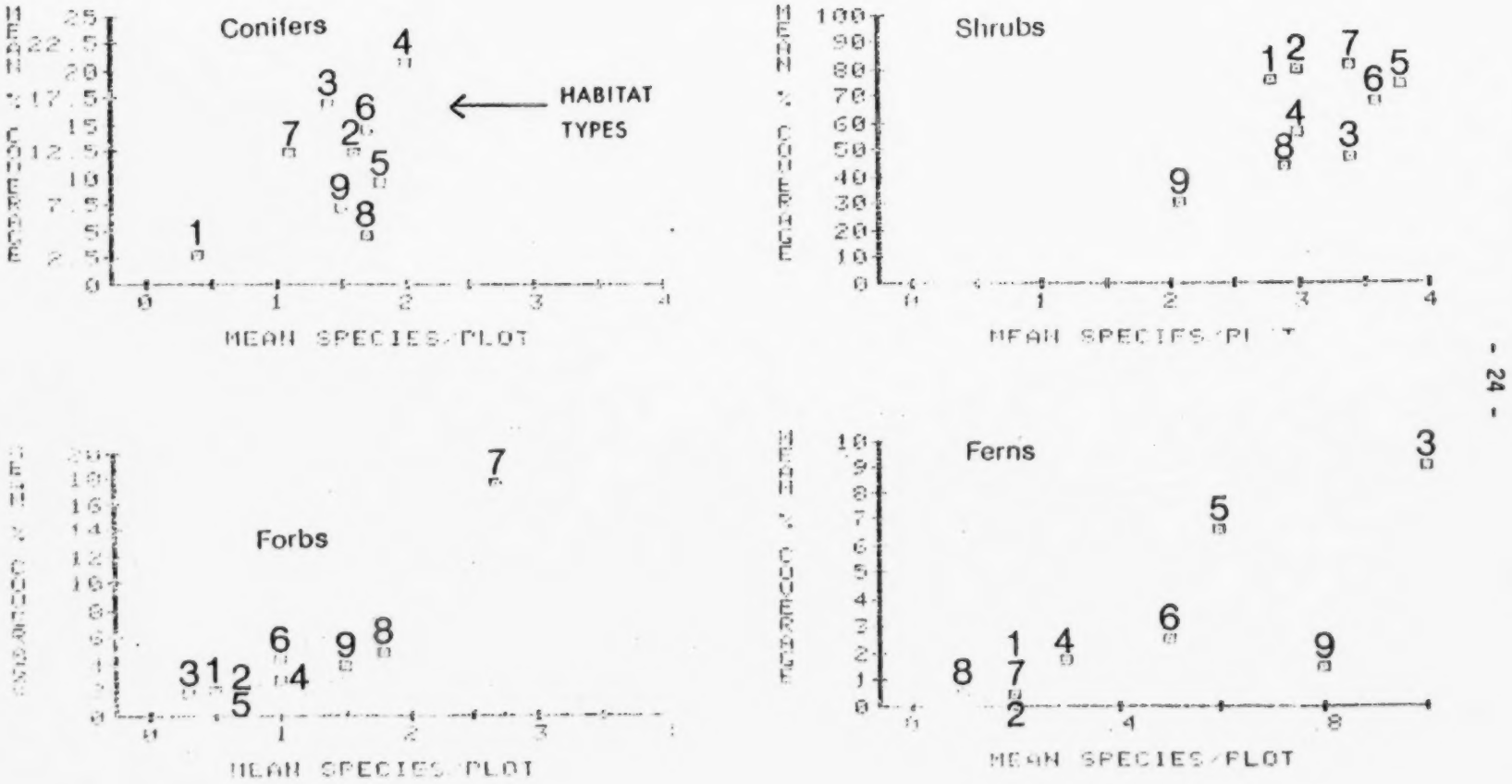


Figure 5. Comparison of the mean number of species per plot (diversity) with mean percent coverage (abundance) by forage class.

Table 11. Correlation coefficients for the correlation between use and (A.) Forage classes and (B.) Species ($r_{crit(0.10,\ df=7)} = \cdot 582$)

A. Forage Class	Corr. coeff.	B. Species	Corr. coeff.
Conifers	.122	Tsuga heterophylla	.183
Shrubs	.376	Linnaea borealis	-.170
Forbs	-.327	Blechnum spicant	-.081
Ferns	.483	Carex spp.	.058
Grasses	.043	Vaccinium spp.	.572
		Polystichum munitum	.626*
		Gaultheria shallon	.058

* significant

elk use indicated only one significant correlation; Polystichum munitum was positively correlated to use ($r = 0.626$, $p < .10$).

5.1.4 Overstory Density

The forested habitats varied significantly in overstory density (Table 12, Figure 6). T-tests indicated that type 9 (residual cedar) had a significantly higher overstory density than type 2 (mature timber) ($p < .001$). Types 5 and 6 (immature conifer forests) showed no significant differences when compared with type 2 ($p > .10$). Type 4 (41 to 60-year-old conifer poor site) had significantly higher overstory density values than types 5 and 6 (21 to 60-year-old conifer, medium - good site) ($p < .01$). There was no significant difference between types 5 and 6 ($p > .50$).

5.1.5 Snow Depths

1983 was a mild winter, with no snow accumulations.

5.1.6 Weather

Temperature and wind speed values recorded for the last three monitoring sessions are shown in Figures 7 to 9. The lowest sample air temperature recorded during the winter was -3.5 C. However, the temperature only dropped below 0 C during two of the five sessions (sessions 2 and 3), indicating an extremely mild winter. The highest wind speed recorded was 10.9 m/sec (39 km/hr) in session 3. High wind speeds (> 25 km/hr) were also recorded during the first

Table 12. Estimates of overstory density in 8 of 9 habitat types on the 1983 winter range

Habitat type	$\bar{x}$	SD	(N)
1	2.4	3.1	(8)
2	59.2	13.3	(36)
3	--	--	--
4	64.5	7.9	(30)
5	58.2	13.4	(46)
6	54.1	17.5	(61)
7	9.3	5.3	(8)
8	no overstory		
9	75.8	5.8	(16)

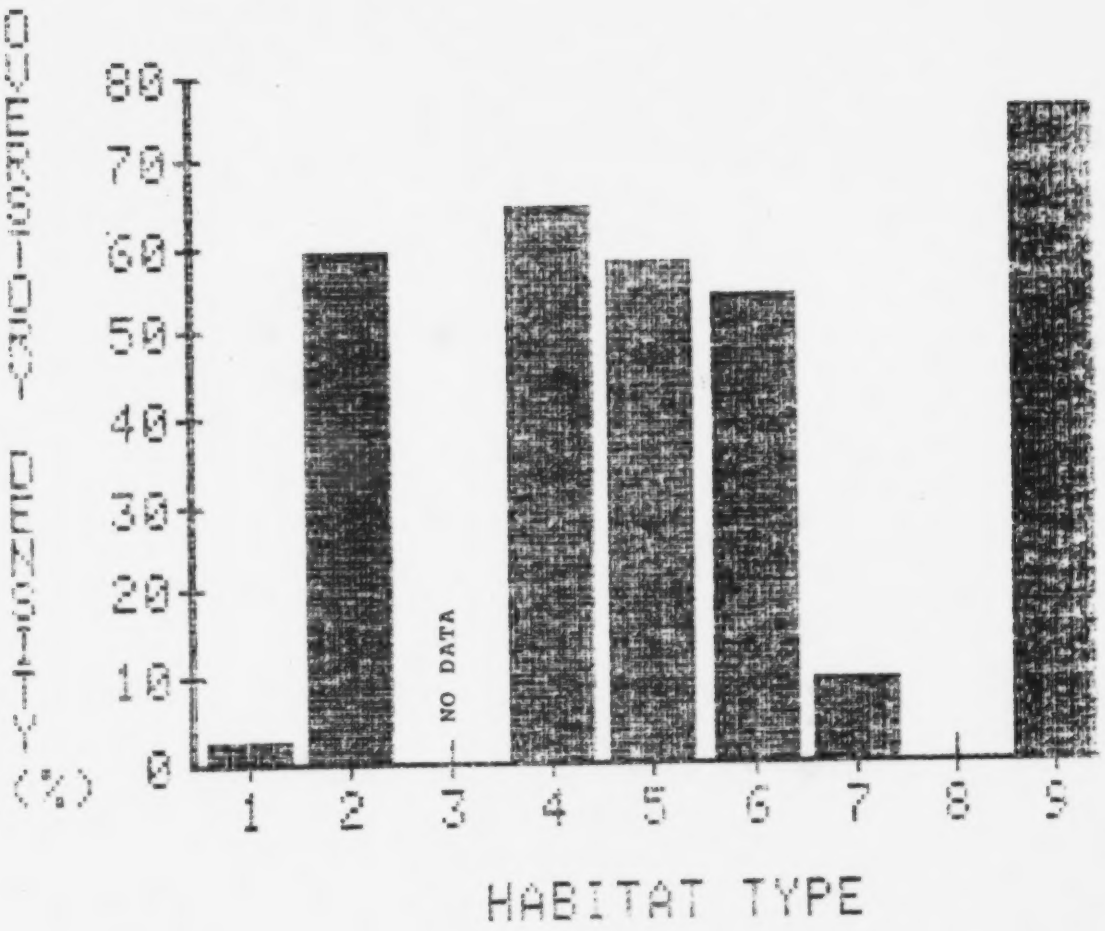


Figure 6. Estimates of overstory density in 8 of 9 habitat types on the winter range (1983)

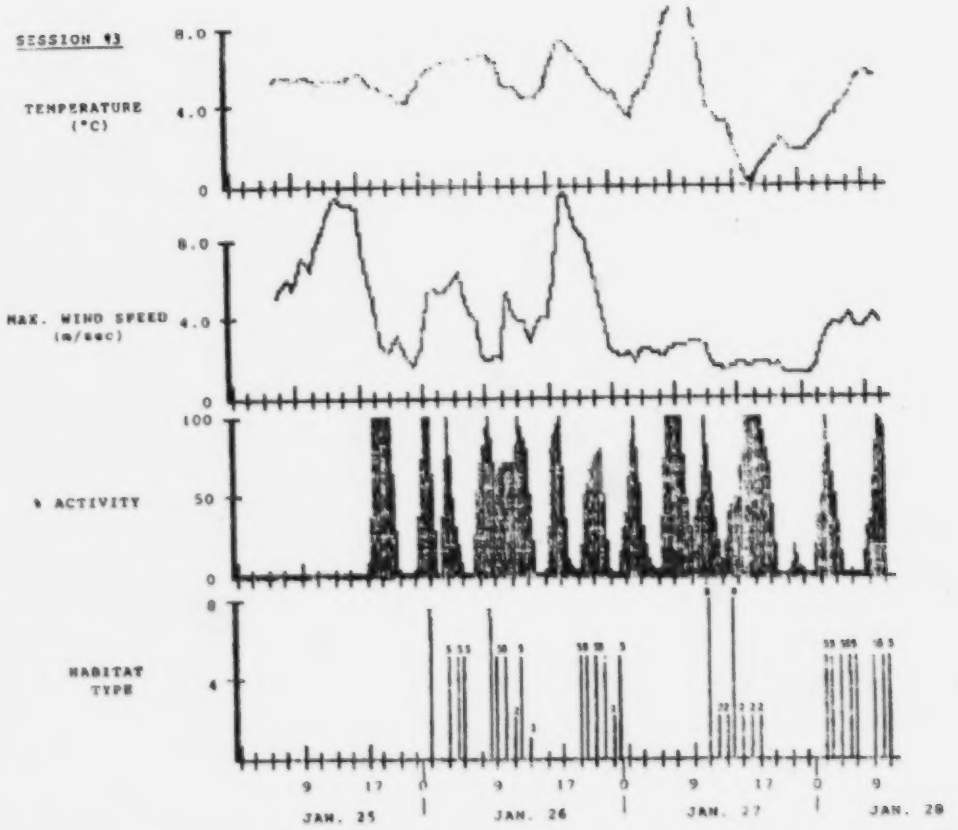


Figure 7. Temperature, wind speed, percent feeding and habitat location patterns in monitoring session 3, Jan 25 - Jan. 28, 1983.

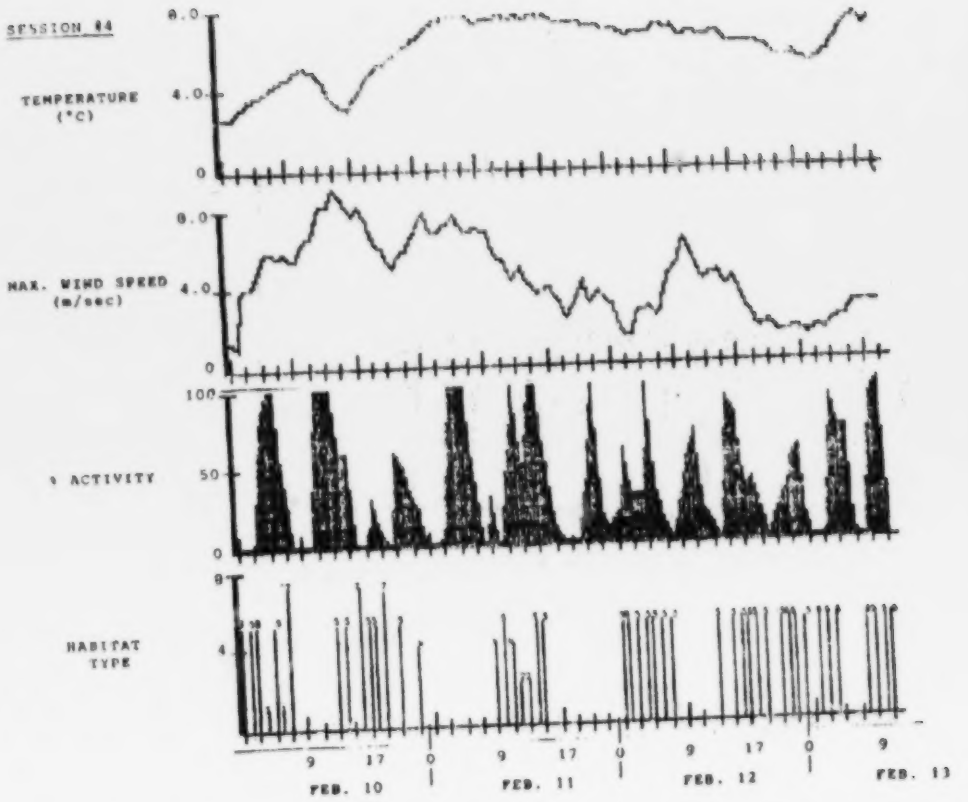


Figure 8. Temperature, wind speed, percent feeding and habitat location patterns in monitoring session 4, Feb. 10 - Feb. 13, 1983.

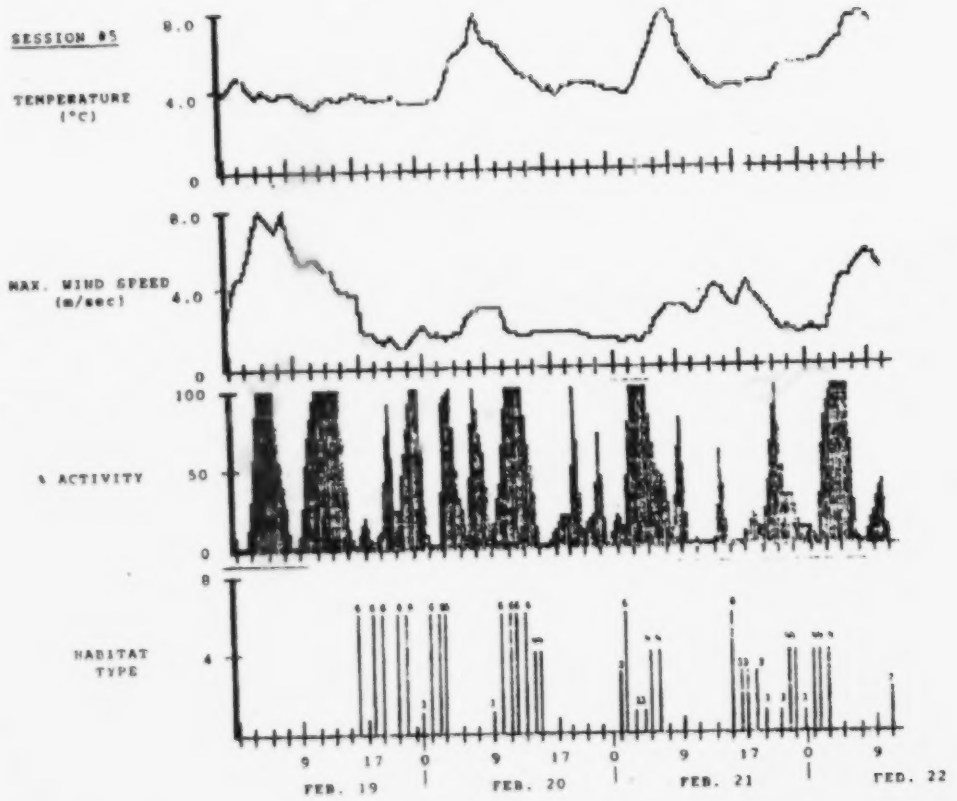


Figure 9. Temperature, wind speed, percent feeding and habitat location patterns in monitoring session 5, Feb. 19 - Feb. 22, 1983.

2 days of session 4. High winds and low temperatures did not occur simultaneously, probably negating the influence of wind chill factor in habitat selection.

No correlations were found between temperature and the overstory density of habitat used, presumably because conditions were not severe enough to cause thermal stress.

Also no correlations were found between wind speed and the overstory density of habitats used. But cursory observations indicate that activity periods may be of a shorter duration during periods of high wind.

5.1.7 Diet

Tsuga heterophylla, grasses, Linnaea borealis, sedges and Blechnum spicant were the five major food items, accounting for 78.8% of the diet (Table 13). On a forage class basis, graminoids (32%) and conifers (25%) dominated the diet (Figure 10).

Rank comparisons of usage and availability (Johnson 1980) of species and forage classes on the winter range indicate that Blechnum spicant, grasses, Lysichitum americanum, and Linnaea borealis were the preferred plant taxa (Table 13). Vaccinium spp., Gaultheria shallon, Cornus canadensis, Spiraea douglasii, Pseudotsuga menziesii, and Mahonia nervosa were not preferred species during this mild winter. Estimates of percent cover of forage classes and species on the winter range were made by adjusting the coverage values for each habitat type by the percent of the winter range that each particular habitat type represented.

Table 13. A rank usage-availability comparison between species composition in the diet and availability on the winter range

Forage class	Species	Occurence in diet(%)	Cover on the winter range(%)	Rank		Difference	Relative Preference
				Usage	Availability		
Conifers[a]	Tsuga heterophylla	23.9	5.99	1	3	- 2	5
	Pseudotsuga menziesii	--	4.64	19.5	5	14.5	15
	Thuja plicata	1.2	1.70	10	12	- 2	5
	Pinus monticola	--	0.21	19.5	17	2.5	10
Shrubs	Vaccinium spp.	3.1	11.01	8	2	6	13
	Gaultheria shallon	3.4	41.52	6	1	5	12
	Mahonia nervosa	--	5.23	19.5	4	15.5	16
	Myrica gale	0.9	2.18	12	11	1	8
	Spiraea douglasii	--	0.89	19.5	13	6.5	14
	Oplopanax horridus	--	0.04	19.5	19.5	0	7
	Alnus spp.	0.4	0.40	14.5	16	- 1.5	6
	Rubus spp.	0.9	2.42	12	10	2	9
Forbs	Cornus canadensis	--	0.42	19.5	15	4.5	11
	Viola spp.	0.1	0.17	16	18	- 2	5
	Lysichitum americanum	0.9	0.04	12	19.5	- 7.5	2
	Linnaea borealis[b]	14.1	2.78	3	7	- 4	4
Ferns	Athyrium felix-femina	3.3	not recorded	7	--	--	--
	Blechnum spicant	8.7	0.70	5	14	- 9	1
	Polystichum munitum	2.5	2.70	9	8	1	8
	Pteridium aquilinum	0.4	not recorded	14.5	--	--	--
Grasses	spp. (unclassified)	20.2	2.67	2	9	- 7	3
Sedges	spp. (unclassified)	11.9	3.14	4	6	- 2	5
Totals - Forage Classes							
Conifers		25.1	12.54	1	2	- 1	3
Shrubs		8.6	67.73	6	1	5	5
Forbs		15.3	4.64	4	3	1	4
Ferns		18.7	3.40	3	4	- 1	3
Grasses		20.2	2.67	2	6	- 4	1
Sedges		11.9	3.14	5	5	0	2

[a] - the conifer class includes litter and all available conifer forage below 2 m.

[b] - Linnaea borealis is an evergreen, herb-like shrub (Hitchcock and Cronquist 1973) which was placed in the forb class because of its occurrence in the herb layer (after Walmsley et al. 1980).

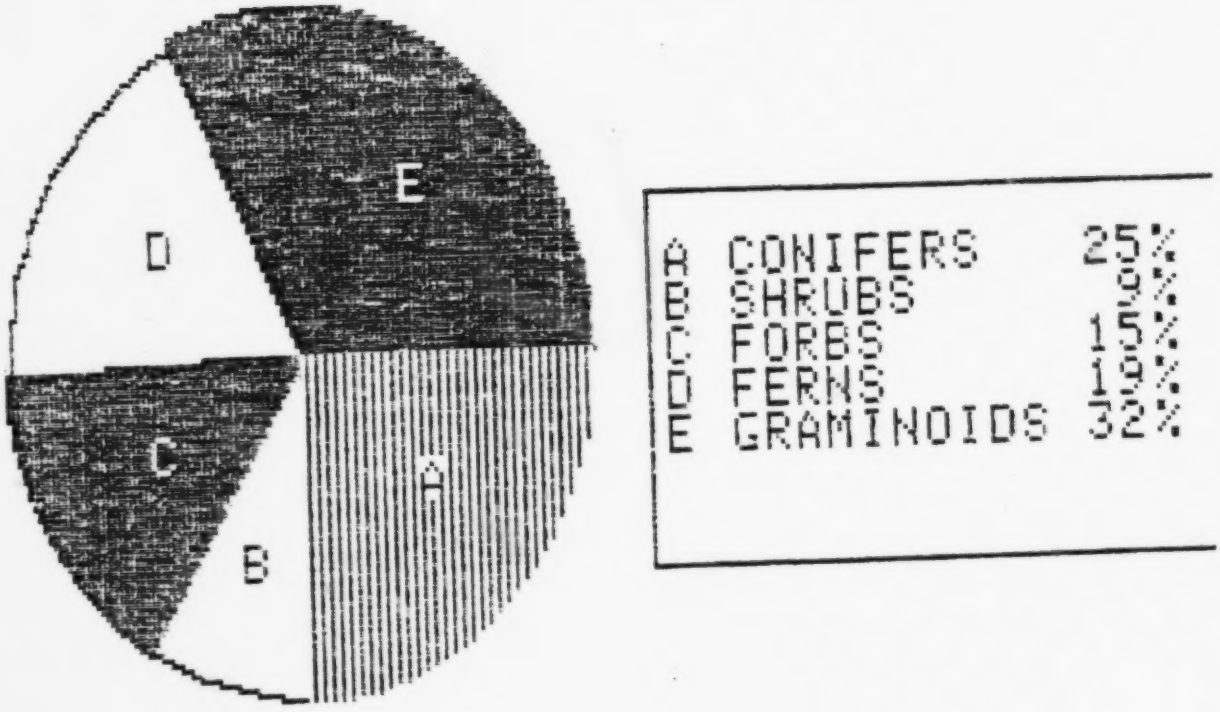


Figure 10. Percent forage class composition of the 1983 winter diet.

5.1.8 Fecal Crude Protein

Percent crude protein values were derived for all pellet collection dates (n = 3) (Table 14). A mean fecal crude protein value of 11.86 (s.d. = 0.38) was calculated for the winter.

5.1.9 Activity

Mean percentages for time in activity and inactivity were 50 and 50, respectively (Table 15). Mean length of activity periods was 1.3 hours, and the mean number of these periods was 9.4 per day.

Activity was related to time of day, with distinct peaks occurring after dawn and before dusk (Figure 11).

Activity was also related to habitat type (Figure 12). Type 1 (bog) had the highest mean percent head up - head down active values. Types 4 and 6 (excluding type 3 due to low sample size) had the highest mean percent inactive values. However activity types were generally not restricted to any particular habitat type.

5.2 Calving 1983

The four monitored adult cows calved on summer range at 425-700 m elevation. From the monitoring, two calving site locations were known and confirmed with observations. A third site was indicated by radio-locations, but was not confirmed with observations. The fourth cow had calved prior to the monitoring, and the location of her calving site was unknown.

The two confirmed calving sites occupied less than 1 hectare (Table 16). The cows remained with their calves at these sites for 10 days. Calving sites were located away

Table 14. Percent fecal crude protein values for the 1983 winter

Collection Date	n	mean % CP
January 16	8	12.08
February 13	9	11.42
February 22	9	12.09
Winter mean		11.86

Table 15. Mean percentages of activity types by monitoring session

Session	Total hours	Active				Inactive		Mean length of activity periods (h)	Mean no. of activity periods/day
		Head up - head down		Head up					
		h	%	h	%	h	%		
3	66.3	24.0	36.2	14.4	21.7	27.9	42.1	1.7	7.4
4	78.2	15.6	19.9	18.9	24.2	43.7	55.9	1.1	11.8
5	78.6	26.3	33.5	10.6	13.5	41.7	53.0	1.2	8.9
Mean %			29.9		19.8		50.3	1.3	9.4

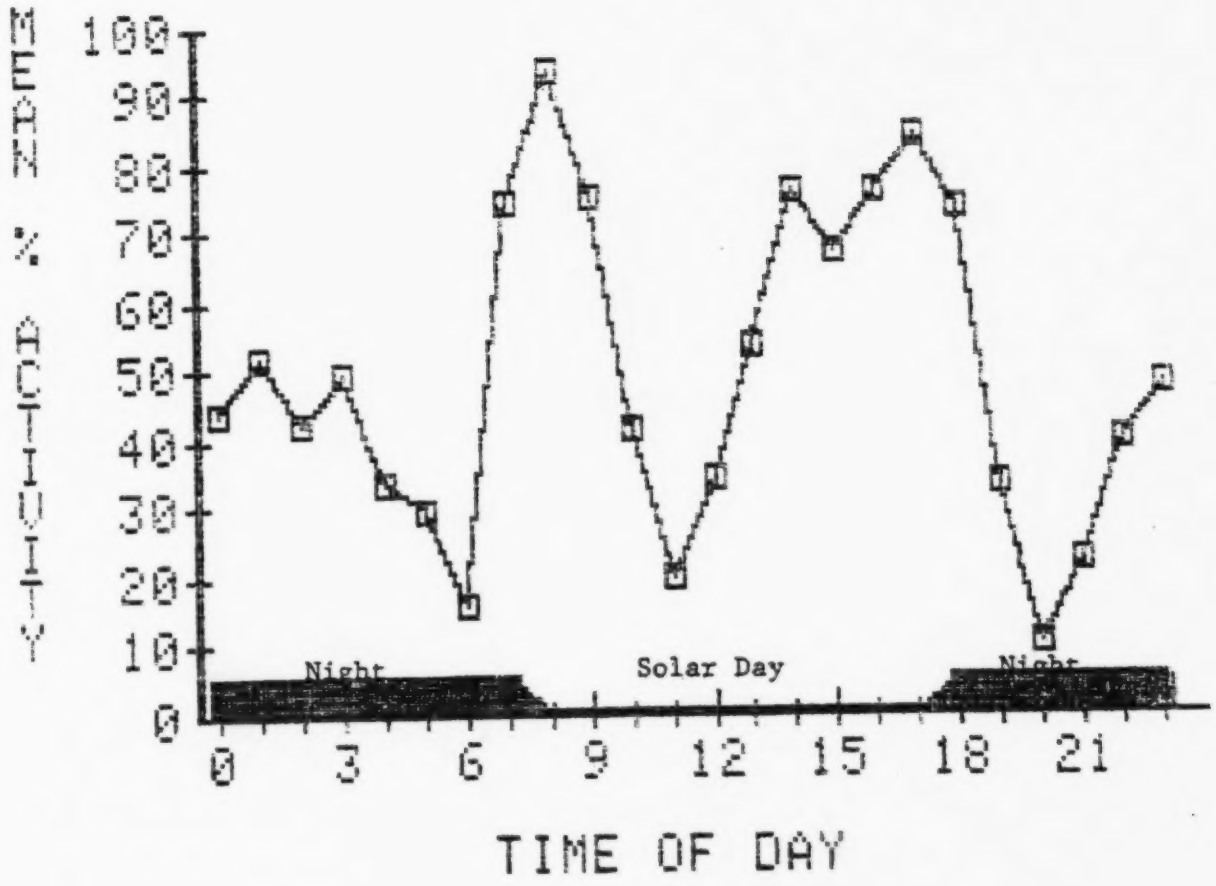


Figure 11. Mean percent activity by hour during January and February 1983.

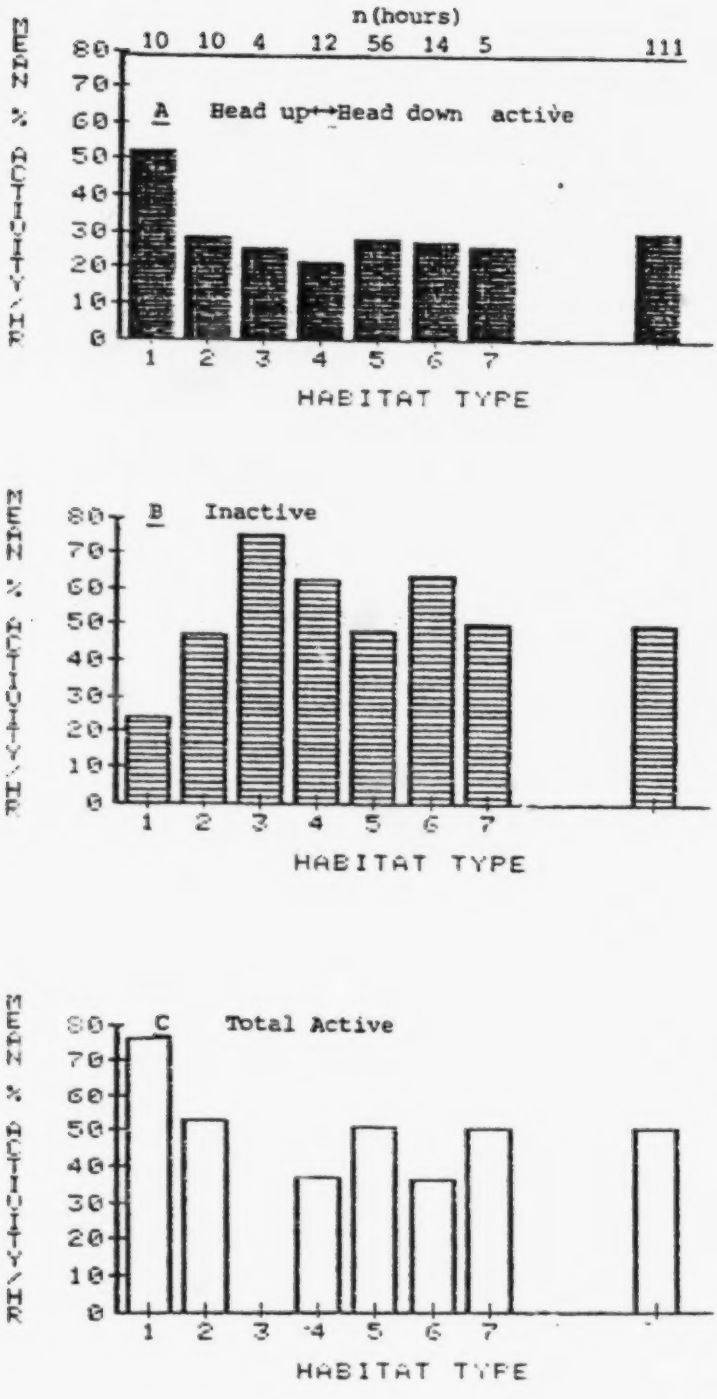


Figure 12. Mean percent activity per hour for 7 habitat types: A. feeding (head up - head down); B. inactive; and C. total activity. Means for each activity type are shown on the right.

Table 16. Home range sizes during calving and calving dates

Animal frequency	Calving date	Monitoring			Home range size
		Dates	Number of days	Days at calving site	hectares
41	June 3	June 2 - June 12	11	10	< 1
251	June 6	May 30 - June 16	18	10	< 1
391	May 20 - 25[1]	May 30 - June 9	11	?	?
1038	late May - early June	May 31 - June 12	13	?	?

1 - estimated time period based on observations of cows and calves on May 31, June 4 and June 5.

from valley bottoms, on benches within steep terrain (Figure 13). On all calving sites there was no overstory, though there was cover within 20-50 m. Due to both topography and vegetation, the sighting tube was completely obscured, in most directions, at distances of 20-80 m from an observer. Other calving site attributes are listed in Table 17. Secondary sites were habitat types adjacent to the primary calving site which were observed to be used as cover.

The two cows which were monitored primarily after calving were using mature timber in 76% of the radio-locations (n = 79) (Table 18). Other types utilized included 6 to 10-year-old conifer, bog and 1 to 5-year-old conifer which were utilized in 13%, 7%, and 4% of the locations, respectively. A chi-square analysis using a Bonferroni Z statistic indicated no significant differences between use and availability; however, the disproportionate size of habitat types available in the present case probably render this technique ineffective in discerning preference (Johnson 1980).

5.3 Population and Animal Condition

5.3.1 Aerial Surveys

Cow-calf classification surveys (Tables 19 and 20) indicate high calf survival over the mild 1982-83 winter and similar (Greenstone herd) to lower productivity (Grilse herd) during the 1983 calving period as compared with 1982 (Table 21).

5.3.2 Kidney Fat Indices (KFI)

The mean KFI values obtained for the 1981 and 1982 samples differed significantly ($p > .05$), and were 104.9 and 46.5, respectively (Figure 14). In both years, the values between males and females did not significantly differ.

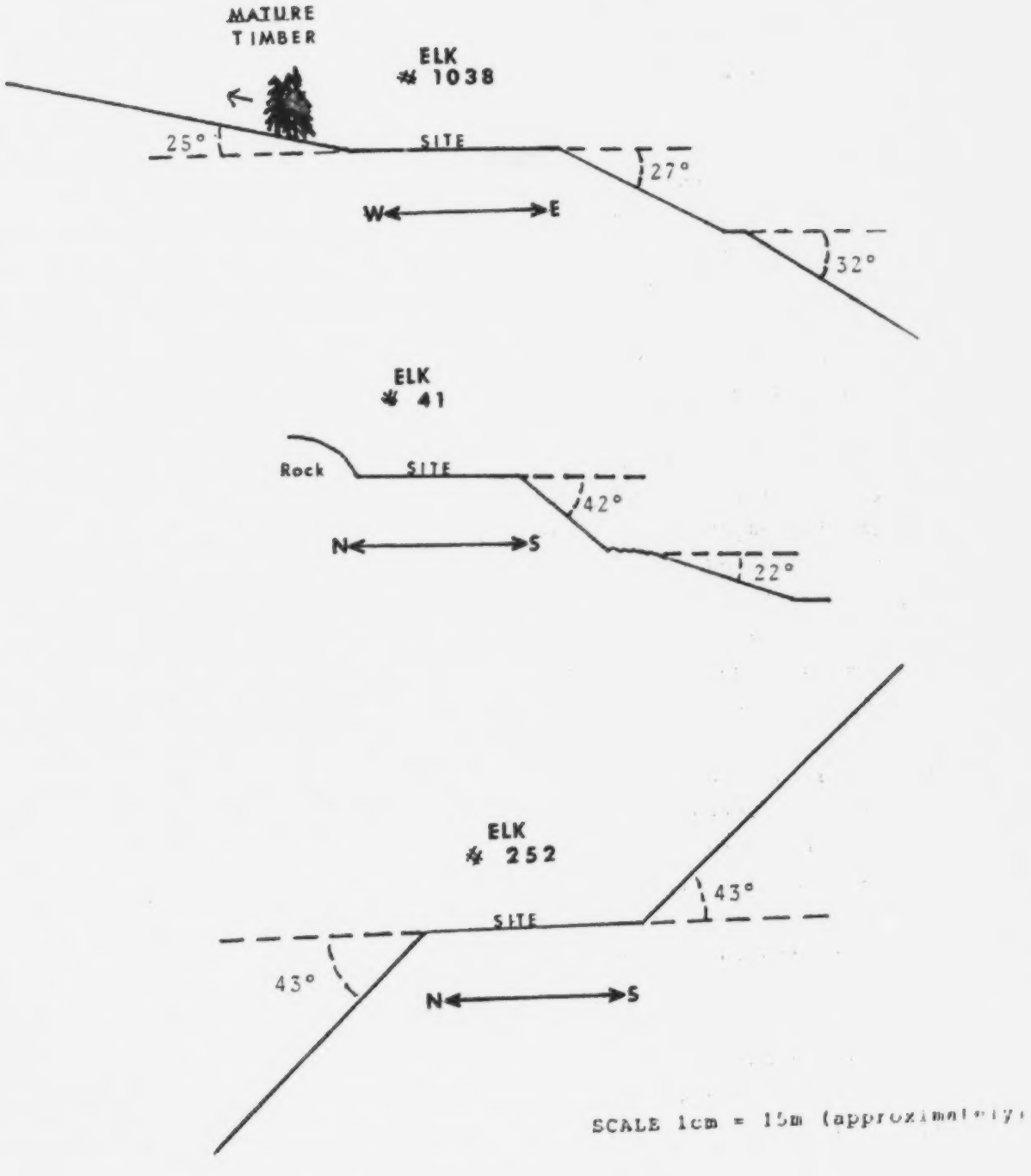


Figure 13. Topographic profiles of three calving sites.

Table 17. Calving site attributes on primary (a) and secondary (b) or adjacent sites

	Cow Monitored					
	#41		#252		#1038[a]	
Site attribute	a	b	a	b	a	b
elevation	670 - 700 m		490 - 520 m		640 - 670 m	
stand type	early regen	early regen and mature timber	meadow	12 yr regen	early regen	mature timber
slope	0°	0 - 20°	0°	10° - 40°	0 - 6°	25°
terrain	bench within steep terrain	rolling	depression within steep terrain	moderate-steep slope	bench within steep terrain	moderate slope
aspect	south	north	north	north	east	east
overstory - height	0	28 - 37 m	0	3 - 4 m	0	37 - 46
- age	--	251 + yrs	--	12 yrs	--	251 + yr
distance to water	< 100 m	< 100 m	< 100 m	< 100 m	< 100 m	< 100 m
distance to mature timber	350-400 m	0-50 m	800 m	800 m	30-50 m	0
distance to cover	20 m	0	20-50 m	0	30-50 m	0
hiding cover - 100% obscured	40-80 m	20-80 m	40-200 m	20-120 m	40-120 m	20-80 m
crown closure	0 %	76-85 %	0 %	8-10 %	0 %	66-75 %
years since logging	7 yrs	not logged	12 yrs	12 yrs	3 yrs	not logged

[a] Tentative site from radio locations (unobserved).

Table 18. Proportion and occurrence of radio-locations of two adult cow elk during the post-calving period in June 1983

Habitat type	Total hectares	Number of locations	Proportion of total hectares ($P_i o$)	Proportion of locations (P_i)	80% confidence interval[a]	Selection
1	21	6	0.042	0.076	$0.018 < p_i < 0.134$	0
2	348	60	0.699	0.759	$0.665 < p_i < 0.853$	0
7	99	10	0.199	0.127	$0.054 < p_i < 0.200$	0
8	30	3	0.060	0.038	$0 < p_i < 0.080$	0
Total	498	79	1.000	1.000		

[a] See Table 6 for reference.

Table 19. Results of spring 1983 cow-calf classification survey, April 14, 18 and 26

Herd	Group	Mature bulls	Spikes	Cows	Calves	U/C	Calves:100 cows	No. of collars observed	No. of collars in area
Grilse	01			13	8			--	
	02			3				--	
	03			9	3			2	
	04			4	3			--	
	05		2	3				--	
	06		1	11	5			--	
	07			2				1	
	08			15	11			--	
	09			5	2			--	
	10			4				1	
	11		5	20	5			3	
Greenstone	01	2	1	12	12			--	
	02	2						--	
	03	2						--	
	04			6				--	
	05					9		3	
	06	2	1	5	1			--	
	07			14	5			--	
	08					1		--	
	09			4				--	
	10	3		6	4			--	
	11	2		4				1	
Lower Salmon	01	1		9	3			--	
	02		1	3				--	
	03	1		10	7			--	
Totals									
Grilse (excl. groups 01 and 02)[a]			8	73	29		40	8	10
Greenstone		13	2	51	22	10	43	4	4
Lower Salmon		2	1	22	10		45	0	1

[a] These groups were seen in the Memekay River drainage and are probably not in the Grilse herd.

Table 20. Results of August 1983 cow-calf classification survey (August 8 and 9)

Herd	Group	Mature bulls	Spikes	Cows	Calves	Calves:100 cows	No. of collars observed	No. of collars in area
Grilse	01	3	1	8	4		1	
	02	1	4	30	10		2	
	03			2			--	
	04			2			--	
	05			16	7		2	
	06		4	28	11		1	
Greenstone	01	1	4	36	20		2	
	02			7	4		--	
Gold Lake	01		2	9	1		2	
Lower Salmon	01	2					--	
Totals								
Grilse		4	9	86	32	37	6	7
Greenstone		1	4	43	24	56	2	3

Table 21. Summary of cow-calf surveys of two migratory herds

Herd & Season	N[a]	S[b]	n[c]	Calves: 100 cows	SD[d]	80% CI	Summer to Spring Change in Ratio	
Grilse Herd							min.	max.
1982 August	120	95	109	49	1.5	47.4-51.2		
1983 April-May			102	40	1.9	37.5-42.5	-10%	-27%
1983 August	130	100	118	37	1.4	35.2-38.8		
Greenstone Herd								
1982 August	80	68	58	49	3.4	44.3-53.1	--	-23%
1983 April-May			73	43	1.7	40.8-45.2		
1983 August	90	75	67	56	3.1	51.8-59.8		

a Population estimate of total number of cows and calves in herd based on composite information from Petersen estimates, radiotelemetry, and general knowledge of the herd.

b Estimated sample size required for estimating calf:100 cow ratio with 3% error and 80% CI (confidence intervals).

c Sample size of cows and calves (n = cows and calves) observed.

d $SD = \sqrt{\frac{N - n}{(n-1)\,N}\,pq}$ (Cochran 1977)

p = calves/cows
q = 1 - p

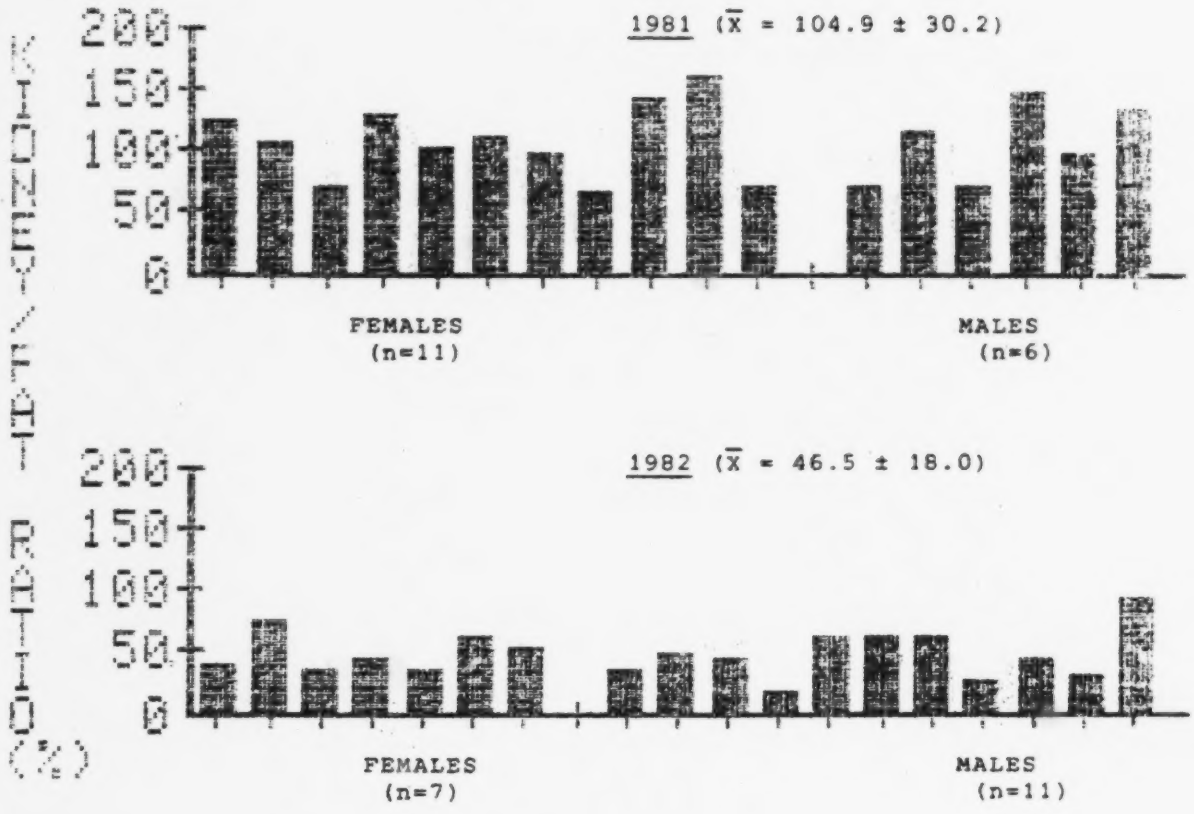


Figure 14. A comparison of 1981 and 1982 KFI values from hunter killed elk in the Salmon River study area.

5.3.3 Fecal Crude Protein (FCP)

Fecal nitrogen and FCP values showed seasonal trends (Figure 15). Values peaked in early summer, and reached lowest levels during mid to late January. No major differences between herd areas for similar collection dates were evident, although records are not complete for all areas and seasons.

Fecal N values peaked slightly earlier and at a higher level in 1982 than in 1981. Values reached 5.0% N during mid-May, 1982 compared to a high of about 4.6% N in late June, 1981.

6 DISCUSSION

6.1 Winter Habitat Use

Habitat use and forage availability results from the 1983 winter must be interpreted with the knowledge that this was a mild snow-free winter; it would be inappropriate to apply these results to other winter weather conditions.

In this mild winter, forage availability was not limited by snow. Also, many species, particularly grasses, remained green. The quality and availability of forage was reflected in the 8.4% dietary crude protein (CP), as estimated from fecal crude protein (FCP) (Janz 1983). This value is well above the critical maintenance value of 5.0% suggested by Mould and Robbins (1981).

Habitat use patterns did not correspond directly with forage availability values in habitat types. As an example, there was no relationship between elk use (locations/hectare) of habitat type and the mean coverage of the top three preferred diet species (Blechnum spicant, Linnaea borealis, and grasses) (Figure 16A). There are three probable reasons

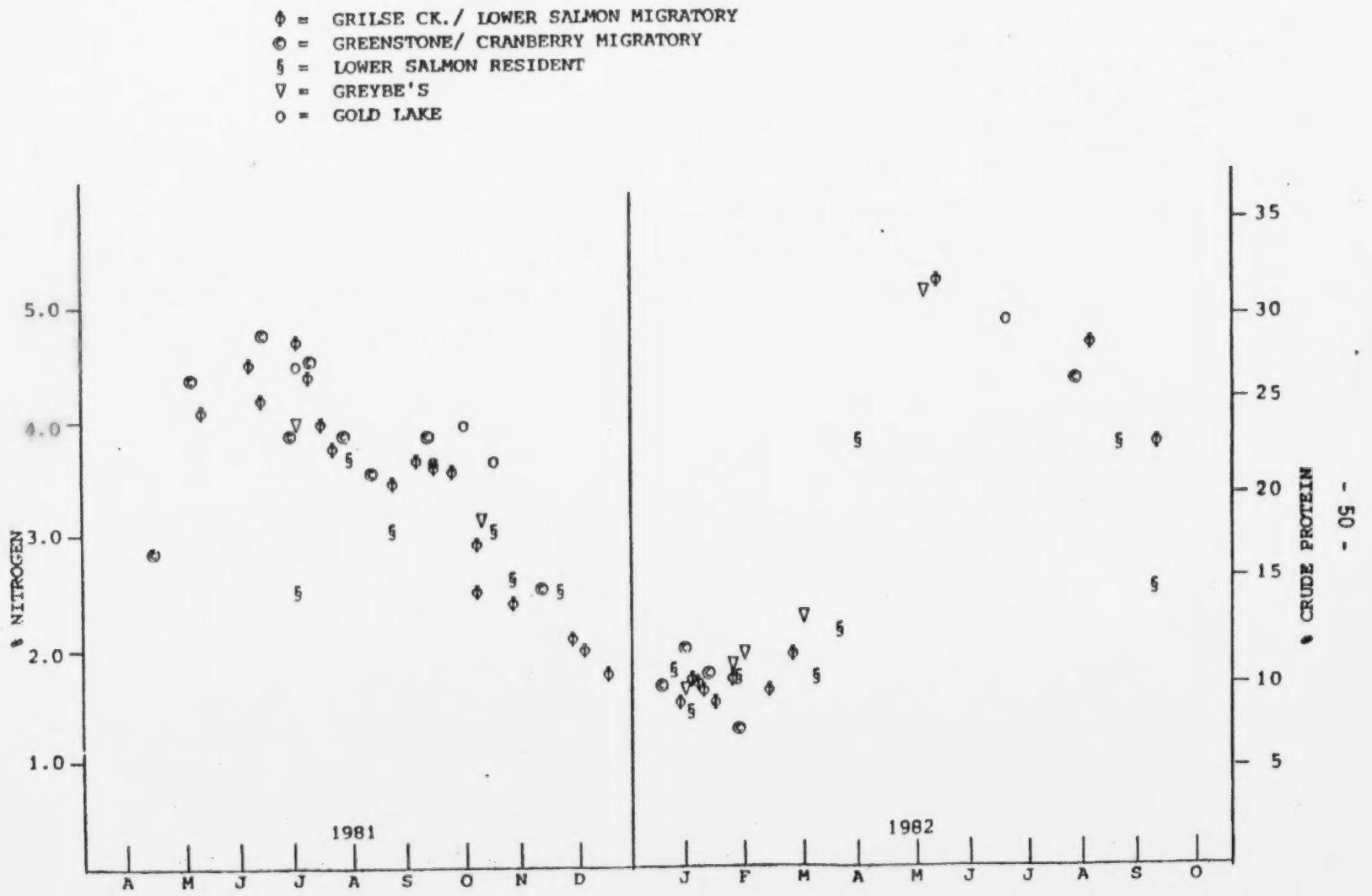
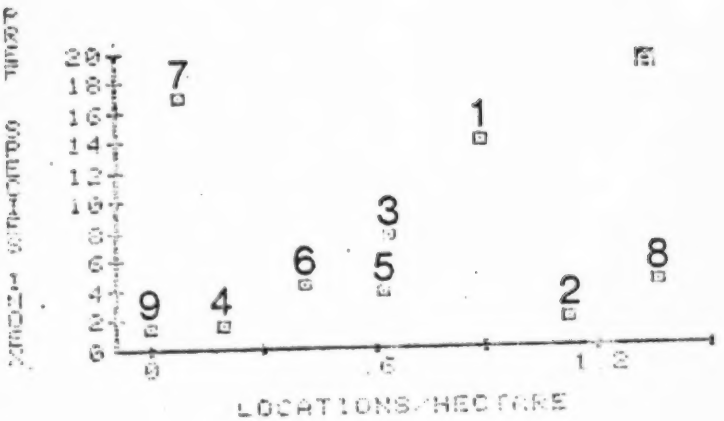


Figure 15. Seasonal pattern in fecal nitrogen values for elk herds in the Salmon River study area, April 1981 to October 1982.



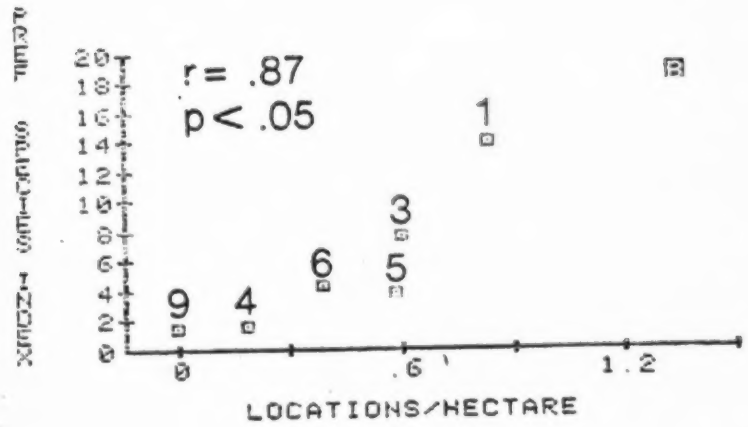


Figure 16. Locations/hectare vs. mean coverage of the top three preferred diet species (Blechnum spicant, Linnaea borealis and grasses) in each habitat type: A. all habitat types; B. all habitat types except young open regenerating stands and mature timber.

for this: (1) due to no snow and high forage availability, the elk did not need to select particular areas to meet their intake requirements; or (2) the elk were selecting for cover and not forage; or (3) the elk were selecting for a combination of cover and forage.

Hypothesis (1), no selection, is not supported by available evidence, since both diet and radio-locations indicate elk preference by species and habitat type, respectively.

Hypothesis (2), cover selection, is also not supported by available evidence, as there is no relationship between overstory density and use (locations/hectare) for all types ($p > .50$), or for cover types ($p < .50$).

The hypothesis that elk selected areas for a combination of preferred forage and cover is supported by the following evidence. There is a significant relationship between use (locations/hectare) and the mean coverage of the top three preferred diet species ($p < .05$), when types 2, 7, and 8 are not included (Figure 16B). The remaining types (1, 3, 4, 5, 6, 9) are all closed cover types or, in the case of types 1 and 3, types in which the elk are hidden or obscured from view. This suggests that the elk are selecting for forage availability within types which also provide visual cover. Extending this hypothesis, habitat type 7 (6 to 10-year-old conifer) would not be heavily used, even though it had high forage value, because it offered low visual cover value. Type 8 (1 to 5-year-old conifer) should also fit into this low use category. However, it had high proportional use. This might be explained by its occurrence adjacent to a heavily used mature timber patch. Type 2 (mature timber) might have been used for its cover value alone.

Observer use of the areas for radio-locating may potentially influence habitat use, possibly causing lower use of openings and higher use of hiding cover. This may explain the high use of cover types observed.

An alternative hypothesis to the above is that elk select for forage availability within types which also provide an adequate abundance of Tsuga heterophylla. Tsuga heterophylla was the major dietary item throughout the winter (24% of diet). The types which have the highest Tsuga heterophylla availability values are types 2, 3, 4, 5, 6 and 9. Types 1, 7 and 8 have low Tsuga heterophylla availability.

Field observations of habitat use indicated that elk used the wetter portions of most types other than bogs. These observations might explain the correlation that was found between elk use and the occurrence of Polystichum munitum, which is found in wetter areas. P. munitum was not a major dietary item.

6.2 Winter Food Habits

Food habits from the 1983 winter must also be interpreted with the knowledge that this was a mild, snow-free winter; many species which were utilized would not be available in a winter with significant snow accumulations.

Fecal analysis has been shown to overestimate less digestible portions of the diet (e.g. shrubs, conifers) and underestimate more digestible portions (e.g. forbs) (McInnis et al. 1983). This bias might contribute to the high occurrence of conifers in the determined diet and the low occurrence of forbs. However, the error in derived diet composition due to differential digestibility is probably not great enough to distort relative ranking of forage species

importance (McInnis et al. 1983). As well, cursory field observations of sites following extended elk use, and the species utilized, corresponded well with the results of the rank usage-availability comparison; generally, wetter portions of habitats which had the highest abundances of ferns (especially Blechnum spicant) and/or grasses received the highest use.

6.3 Calving Habitat Use

Cover requirements during calving remain uncertain due to small sample size. Although none of the 3 cows were observed to calve in mature timber, use of this type was high during the post-calving period.

During the 1983 field season we learned that sampling cow locations once per day would probably be adequate to discover calving sites. Therefore, during next calving season, total sample size will be increased to 12-13 calving sites if 9-10 cows can be followed.

6.4 Population

Low calf: 100 cow ratios obtained for the Grilse herd during August 1983 may be due to high survival of calves and yearlings (non-productive) over the previous year or increased predation on calves. The hypothesis of higher predation of calves in the Crilse herd will be examined through analysis of predator scats collected on the calving ranges of the Grilse and Greenstone herds; higher wolf and bear scat densities occurred on the Grilse range.

6.5 Kidney Fat Index

Variability in KFI has been attributed to differences in condition, age, sex, and seasonal kidney weight fluctuations (Janz 1979). Sex-related differences in our samples were believed to be small since no significant differences were found between male and female KFI values in either year. An age effect seems unlikely, since age distributions between years did not differ greatly. Samples in both years were collected in the same season so that kidney weight fluctuations between seasons would not be an influencing factor.

Thus the observed differences in KFI levels between the two years was likely due to differences in condition. One major difference between years was winter severity. The 1980/81 winter was relatively mild with low snowfall, while the 1981/82 winter was moderate with significant snow accumulations. If differences in KFI values between fall seasons is related to winter severity in the previous winter, this would suggest that winter weather in a particular year may have a longer term influence on animal condition and performance than just 6 months to a year.

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8 APPENDIX

8.1 Percent forage class coverage by plot in habitat types 1 through 9.

8.1.1 Percent forage class coverage by plot in habitat type 1 (bog)

8.1.2 Percent forage class coverage by plot in habitat type 2 (residual mature timber).

8.1.3 Percent forage class coverage by plot in habitat type 3 (deciduous-conifer complex).

8.1.4 Percent forage class coverage by plot in habitat type 4 (41-60 yr conifer - poor site).

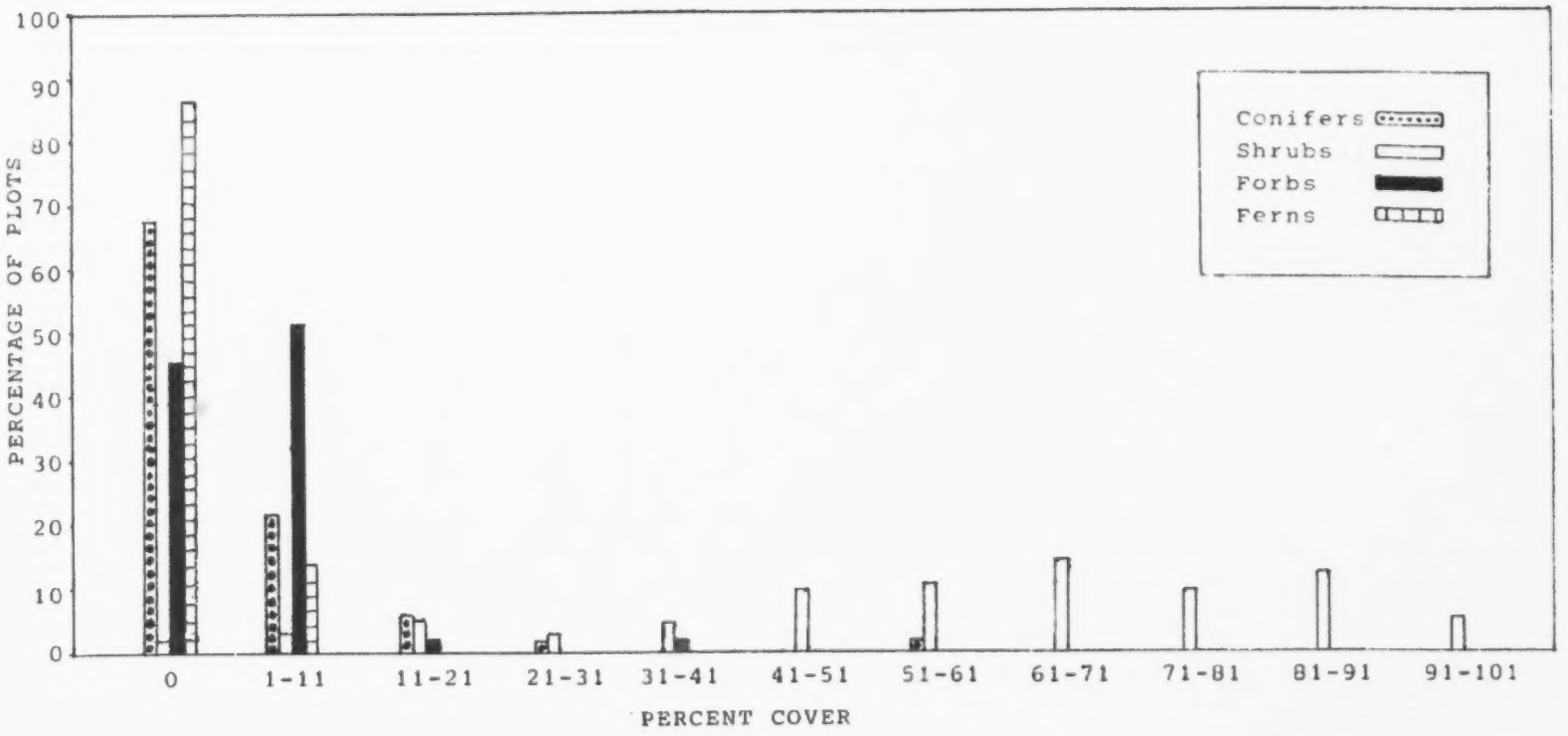
8.1.5 Percent forage class coverage by plot in habitat type 5 (41-60 yr conifer - med-good).

8.1.6 Percent forage class coverage by plot in habitat type 6 (21-40 yr conifer - med site).

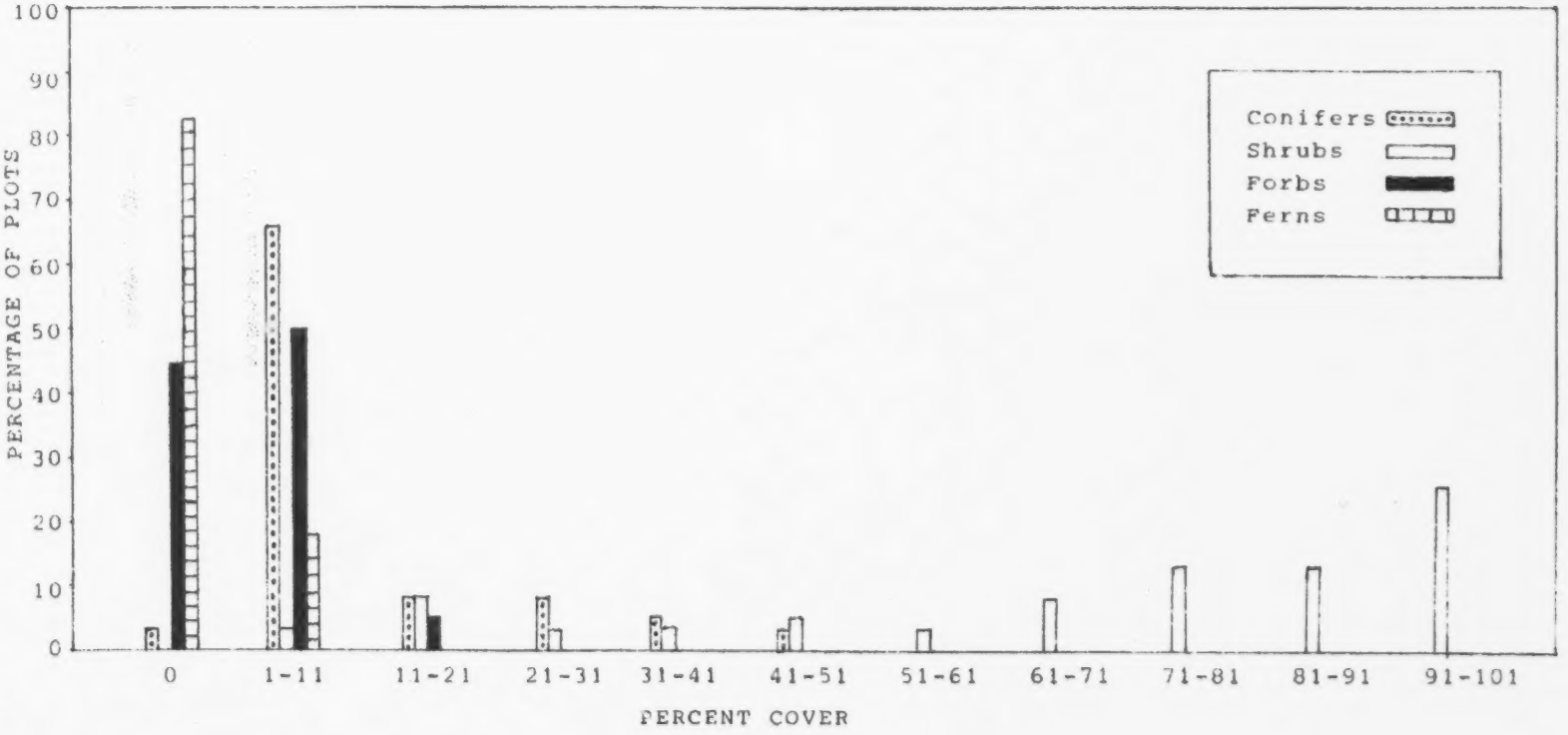
8.1.7 Percent forage class coverage by plot in habitat type 7 (6-10 yr conifer).

8.1.8 Percent forage class coverage by plot in habitat type 8 (1-5 yr conifer).

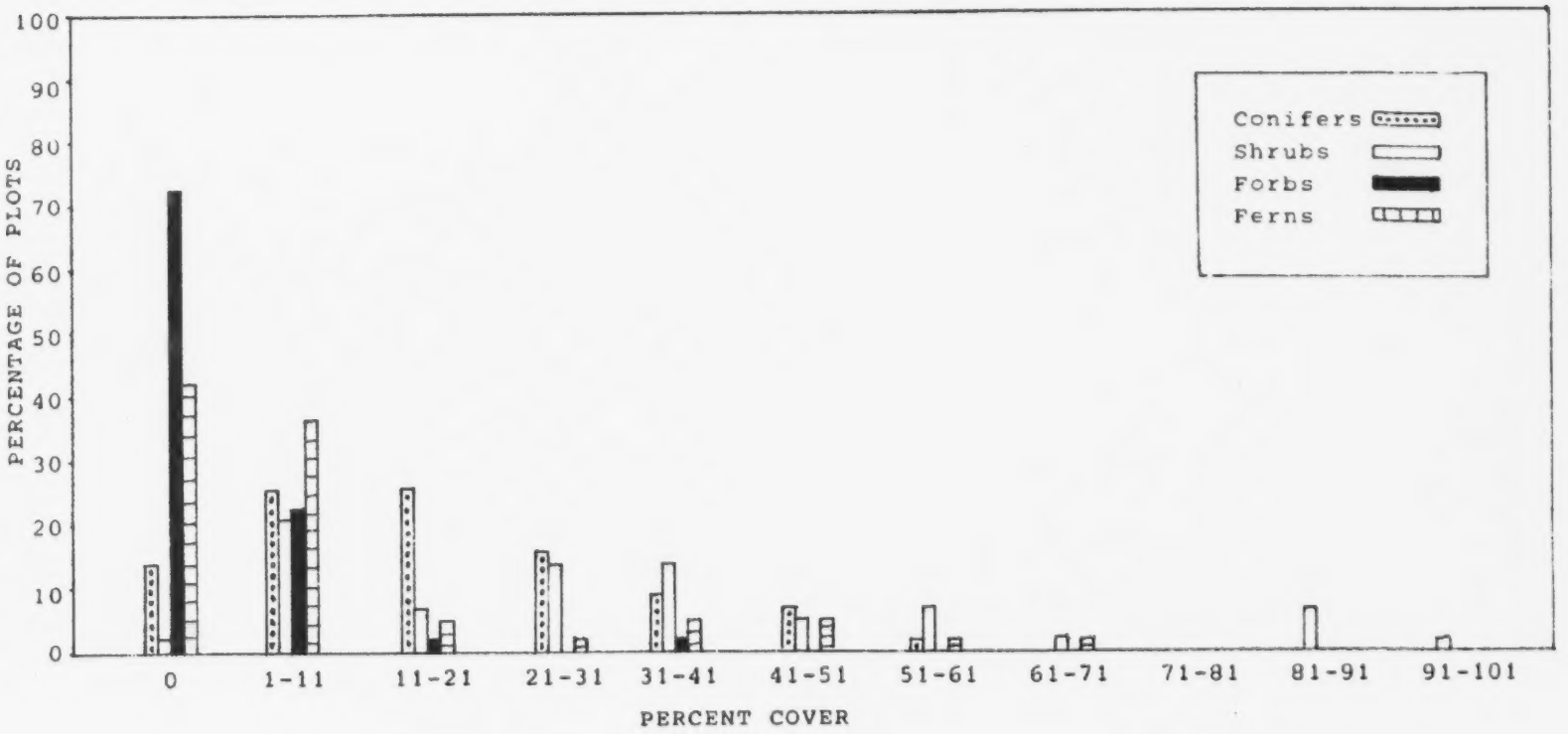
8.1.9 Percent forage class coverage by plot in habitat type 9 (residual cedar).



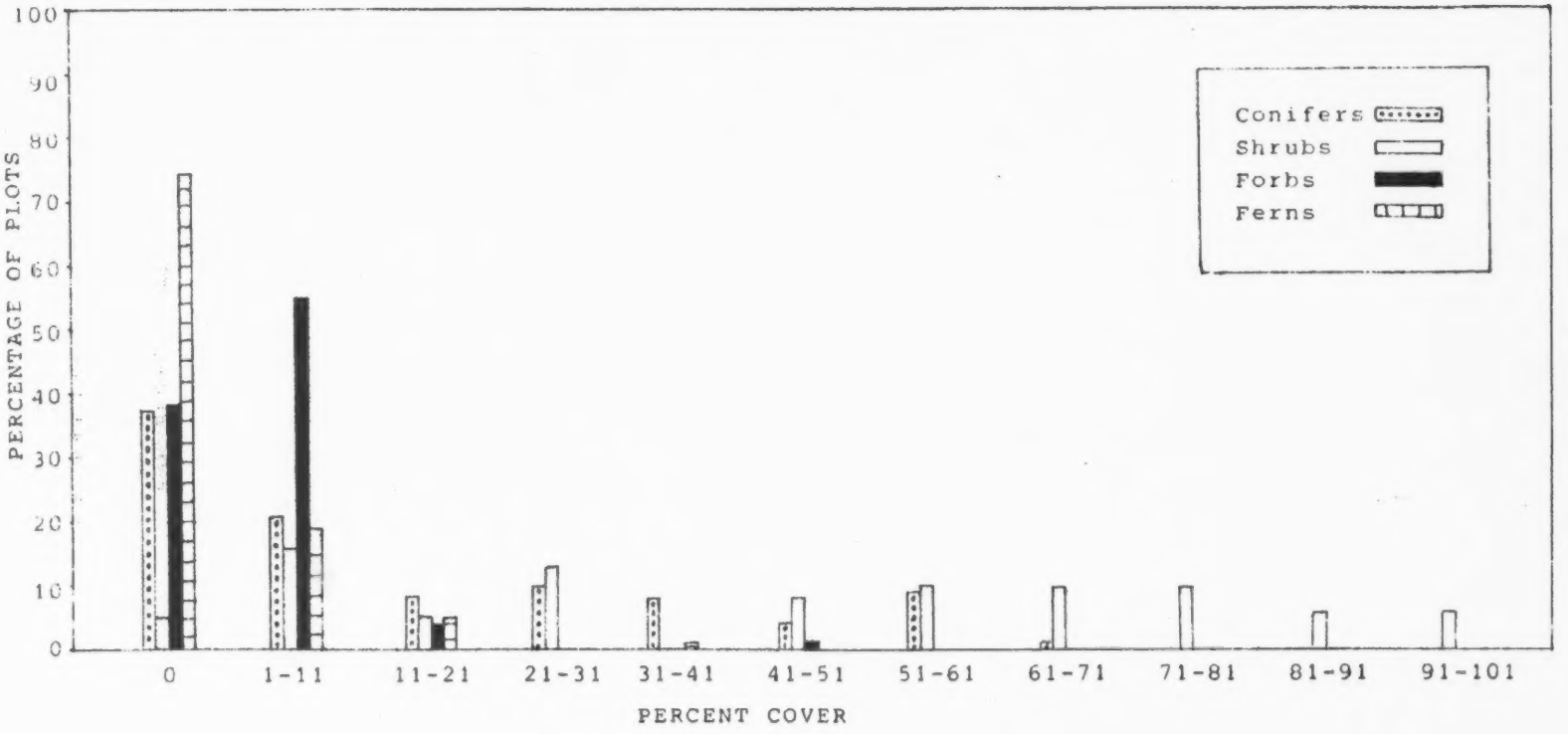
8.1.1 Percent forage class coverage by plot in habitat type 1 (bog)



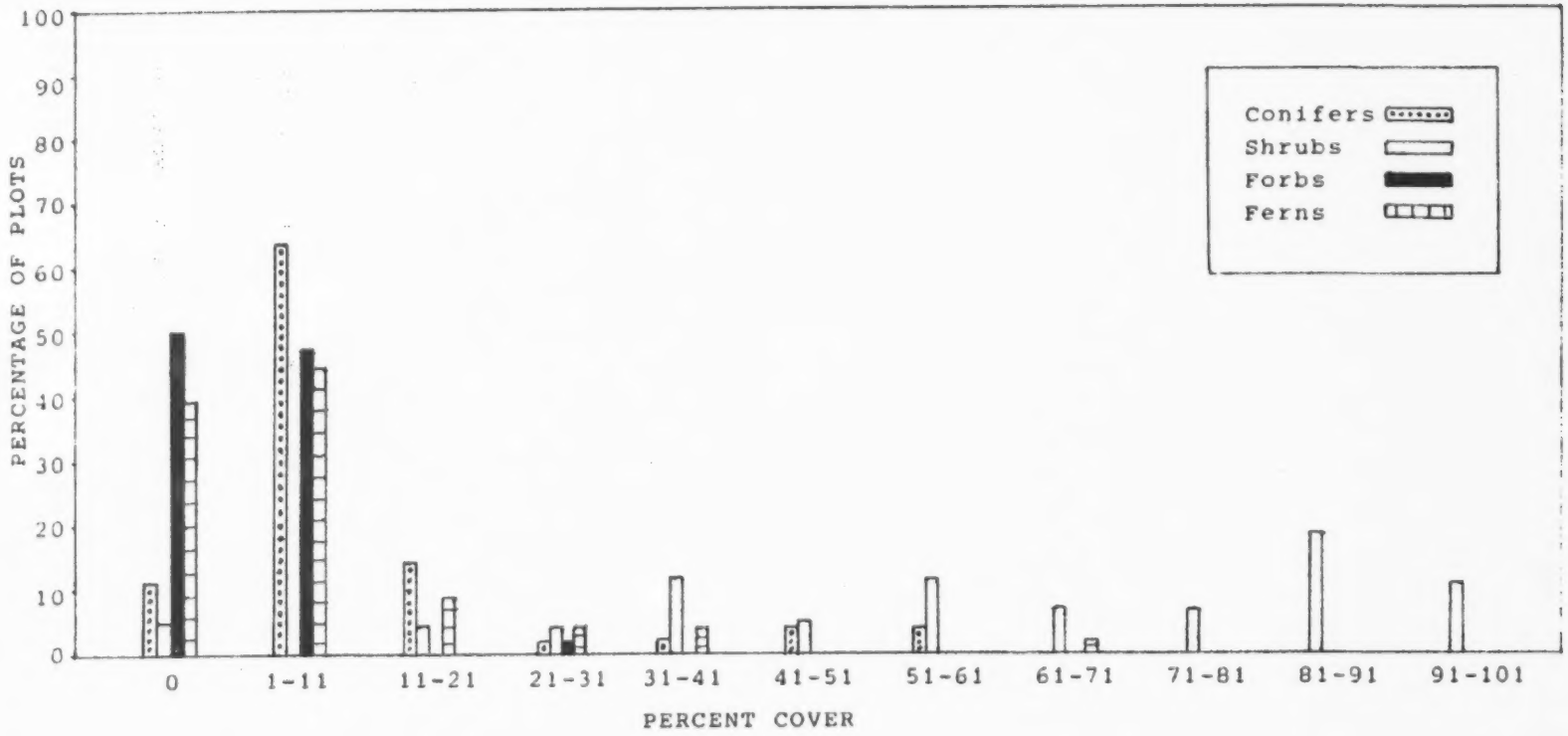
8.1.2 Percent forage class coverage by plot in habitat type 2 (residual mature timber).



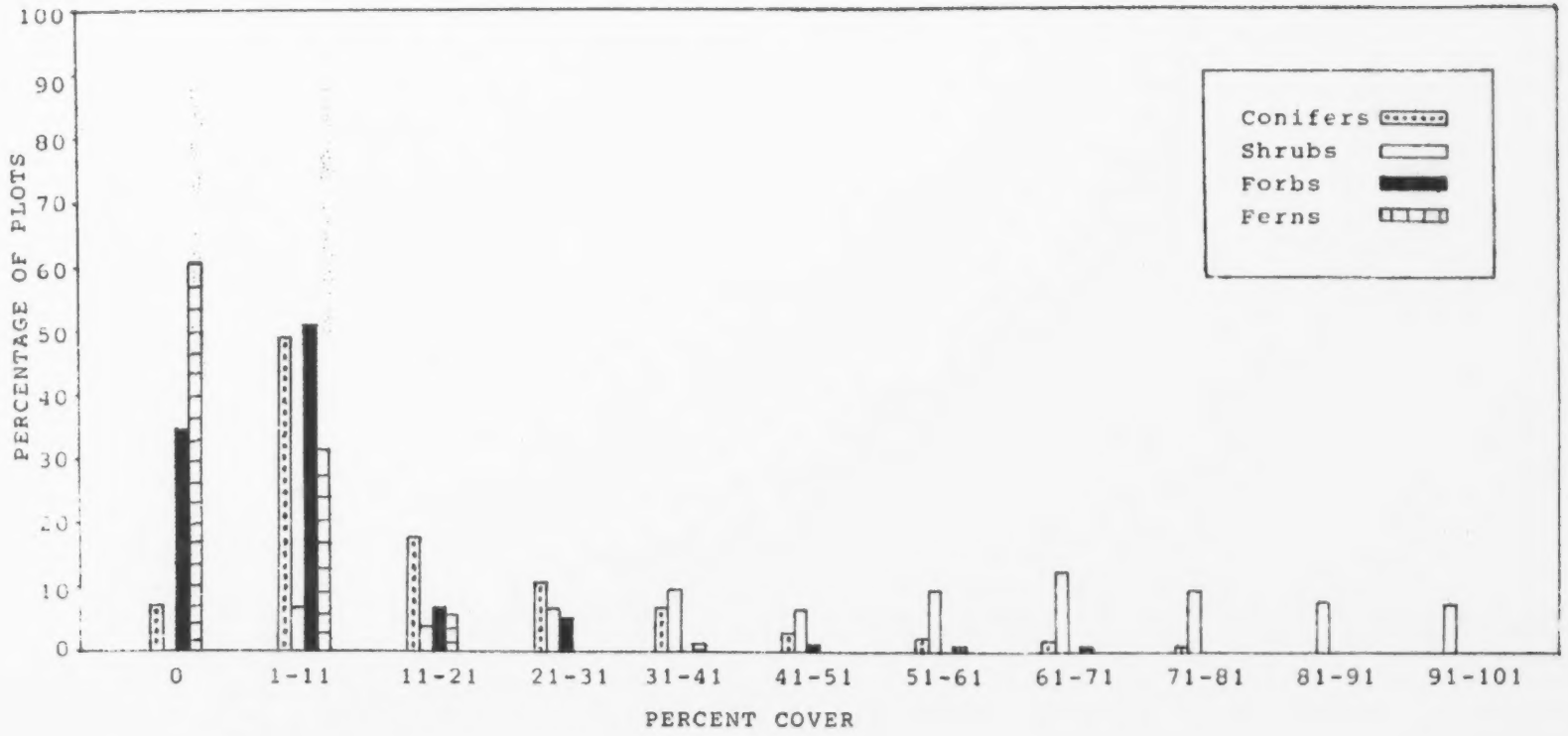
8.1.3 Percent forage class coverage by plot in habitat type 3 (deciduous-conifer complex).



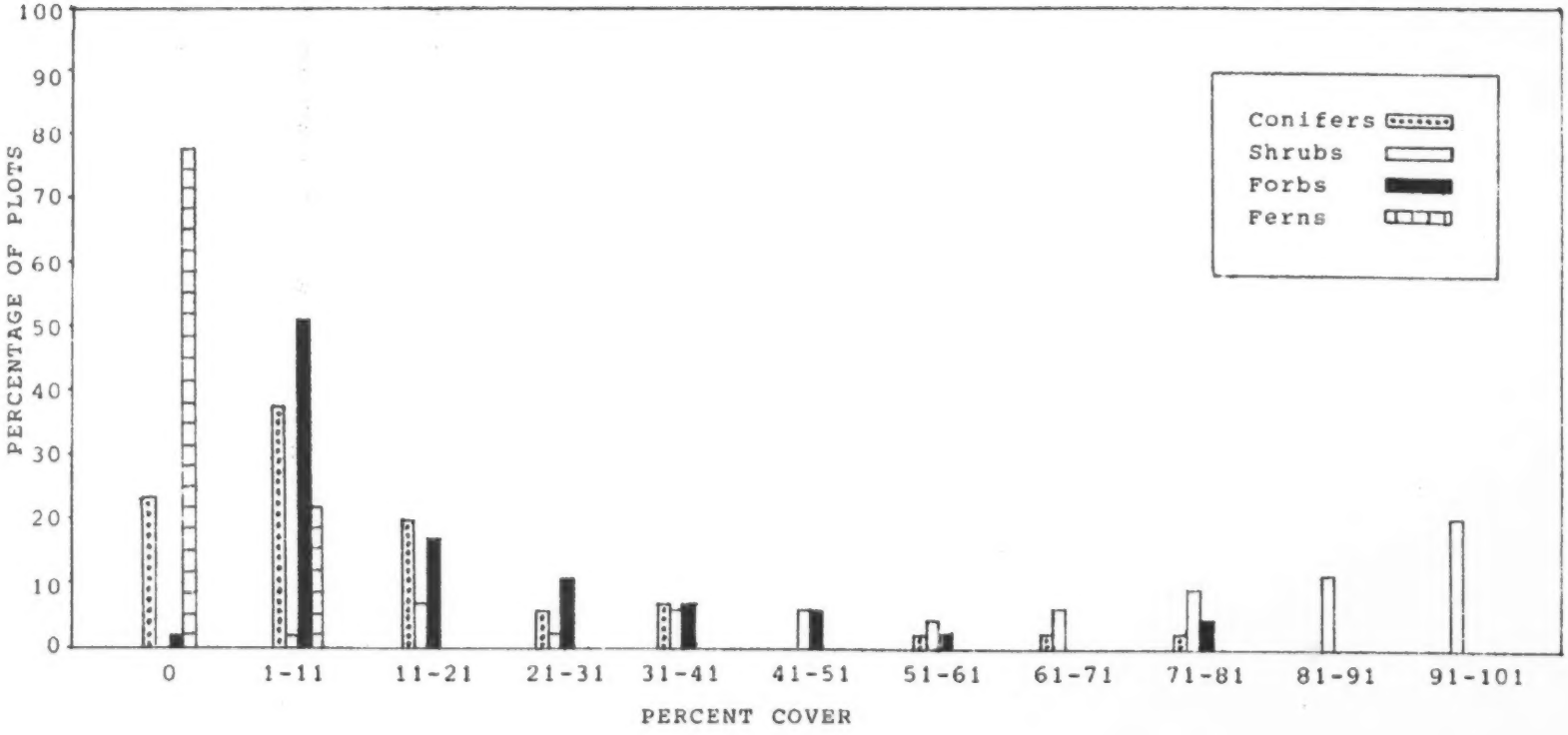
8.1.4 Percent forage class coverage by plot in habitat type 4 (41-60 yr conifer - poor site).



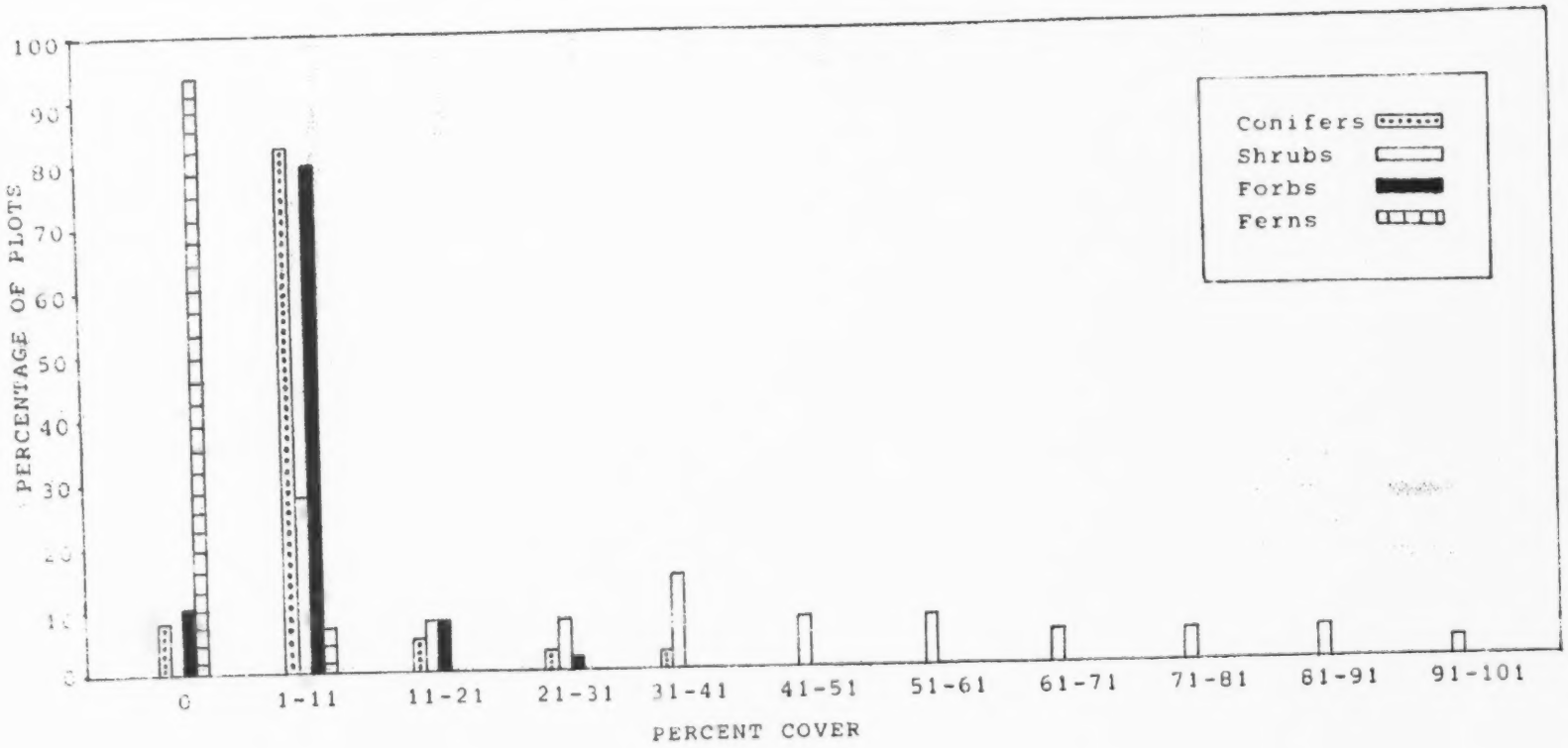
8.1.5 Percent forage class coverage by plot in habitat type 5 (41-60 yr conifer - med-good).



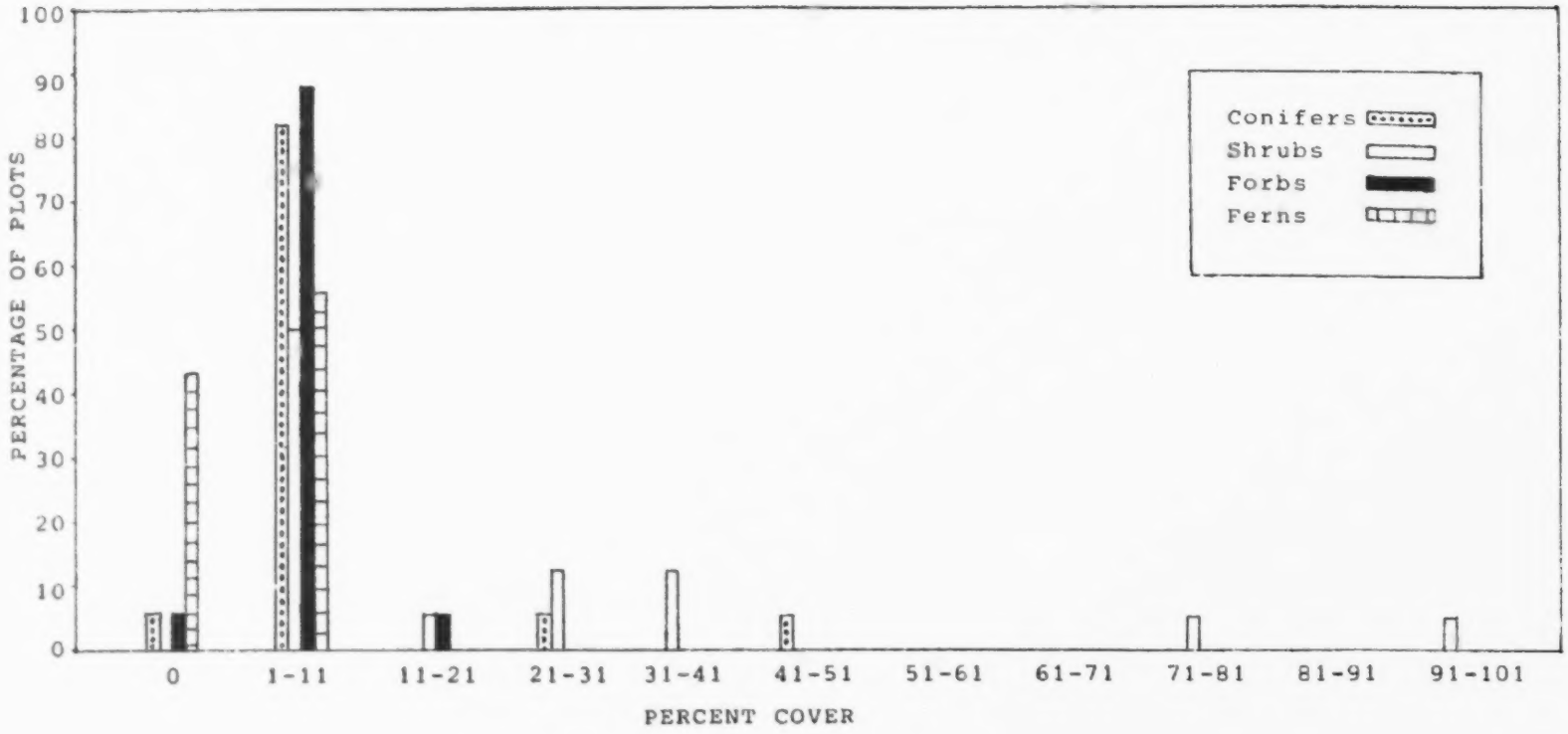
8.1.6 Percent forage class coverage by plot in habitat type 6 (21-40 yr conifer - med site).



8.1.7 Percent forage class coverage by plot in habitat type 7 (6-10 yr conifer).



8.1.8 Percent forage class coverage by plot in habitat type 8 (1-5 yr conifer).



8.1.9 Percent forage class coverage by plot in habitat type 9 (residual cedar).